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INTRODUCTION

In place of the usual introduction to this report it is proposed this year to follow the example of the Commonwealth Agricultural Bureaux and to give an outline of

Salient Points

Maize breeding work has progressed and there are now three outstanding double hybrids combining high yield with good keeping qualities; one of these is now being bulked for distribution. In addition there are some good synthetic varieties, one of which has a high degree of resistance to *Puccinia polysora*. These varieties were tested over a large range of conditions and results generally confirmed those at the Experiment Station.

In work on **maize agronomy** it was shown that responses to nitrogen were economic in most areas of the country and a table shows the responses over a range of soil types. Population trials confirmed that 13–14,000 plants per acre gave the best yield and emphasized the importance of obtaining a full stand. The importance of weeding was again demonstrated.

Sorghums and **millets** are important in a few areas and it was demonstrated that finger millet can give high yields with added fertilizer and without the necessity for the wasteful vizozo burning of wood.

In **groundnut** variety trials Mwitunde again gave good yields at the higher elevations and Early Runner and Dixie Runner were as good or better. The oil content of varieties was well maintained and this was somewhat higher at the lower elevations. In fertilizer trials it was shown that sulphur had a marked effect on yields in the Northern Province and phosphate also gave some increase. An investigation into the occurrence of " pops " again showed that this seemed to be due to a high potassium-calcium ratio. A weeding trial demonstrated the deleterious effect of late cultivations provided that rosette disease is not a serious problem.

Groundbeans gave an exceptionally good yield when planted early as did selected **Canadian Wonder** beans when planted at the end of January.

A **cassava** variety trial showed that the local varieties which are susceptible to mosaic gave better yields than resistant varieties except for one type which is bitter and not popular.

In dark **tobacco** trials local selections gave the best yields and the value of nitrogen and phosphate on yield and quality was apparent. Cultivation trials showed the value of topping and priming and demonstrated the great loss in yield from late planting. A **Burley** variety trial showed there was little to choose between the best four varieties. Another trial showed that no topping decreased the amount of " red " leaf while not affecting the amount of " coloury "; closer than normal spacing not only increased the yield but also gave slightly more " coloury " leaf. Different sources of nitrogen had no effect on the yield, but high nitrogen application decreased the amount of " coloury " leaf.

Cotton variety trials demonstrated the general superiority of the Albar variety though some new crosses were promising. Some varieties from Uganda had a rather higher ginning out-turn than local varieties but they were markedly lower when grown in the Lower River area than when grown in Uganda. Investigations into the product of the cotton seed oil mill showed that the quality of the oil and cake was satisfactory.

Red bollworm investigations were mainly concerned with the life history of the insects and the effect of various insecticides. Good control can be achieved by spraying 8–12 times during the season with Endrin. American bollworm is killed more easily with D.D.T. Investigations on **stainers** showed that there was a lower population where the main alternate host had been eradicated but populations were low and further work is required.

Rotation experiments necessarily take many years to mature but some additional evidence accumulated during the year on the effect of fertilizer applications on leys and the order of cropping during the arable period.

Grassland work continued with experiments on the carrying capacity of Rhodes grass, the spacing and fertilizing of Napier grass and some interesting observations on the comparative feeding value of bush and vlei grasses.

There were many experiments at the **Tea** Stations which are impossible to summarise here and those interested must look at the relevant section. A special note may be made about the first report on the investigation into tea fermentation by the Biochemistry Laboratory, Cambridge.

The **tung** industry has suffered a setback from falling prices and experimental work has been reduced to the maintenance of a few trials on fertilizers, clonal yields, etc.

Coffee is becoming of increasing economic importance and numerous experiments have been initiated. The effect of different varieties of shade trees is to be noted and some early yield figures have given an indication of the yielding capacity of a range of varieties collected from various countries. A trial on the age and method of planting seedlings showed that the normal method gave most vacancies, but this is thought to be seasonal. Experiments on the rooting of cuttings will have value in future seed production.

Fruit and **vegetables** are of minor economic importance but there are some useful experiments on irrigation requirements of strawberries as well as various variety and fertilizer trials.

Irrigation experiments at Makanga are of very great interest, especially the yields of various crops with varying rates of water regulated according to the open pan evaporation rate. The values of various crops grown under irrigation are also of importance.

Most of the **chemistry** work is reported under the various crop headings but note should be taken of the effect of various crop treatments on soil nitrate release.

Work on **soil physics** has been begun comparatively recently and generally speaking annual crops do not suffer a water strain in Nyasaland. Some details of the effect of various crops in removing water from the soil will be found in this section.

An **agro-ecological** survey of the country has begun which will amplify the previous work with greater emphasis on the soil aspect. Surveys on two districts are reported which will later be incorporated into the survey of the whole country.

Most of the work of the **Plant Pathologist** and **Entomologist** is reported under the various crop headings but note should be taken of a number of new species of diseases and pests that have been recorded during the year. An experiment on stalk borer control showed the value of D.D.T. in areas where this pest is severe.

Finally readers are referred to the list of **publications** by Officers of the Department during the past three years and reference should be made to this for more detail on some aspects of the work that has been done.

LIST OF EXPERIMENT STATIONS AND STAFF LIST

The experiment stations in operation during the period under review, and the officers who have been in residence, are listed below:

Agricultural Research Station, Chitedze, Box 158, *Lilongwe.*

Senior Agricultural Research Officer ..	H. B. AMBROSE, B.SC. (AGRIC.) (LOND.), DIP. AGRIC. (CANTAB.)
Agricultural Officer (Tobacco) ..	J. W. DRUMMOND, B.SC. (HONS) (EDIN), D.T.A.
Agricultural Officer (Tobacco) ..	H. ROSTRON, B.SC. (LEEDS), D.T.A. (TRIN.)
Agricultural Officer (Agronomist) ..	P. BROWN, B.A. (CANTAB.), D.T.A., (TRIN.)
Plant Breeder	R. T. ELLIS, B.SC. (LOND.), DIP. AGRIC. SC. (CANTAB.)
Agricultural Chemist	R. A. WOOD, B.SC. (MANCH.)
Assistant Chemist	W. D. CHONA, B.SC. (RHODES)
Farm Manager	P. F. LARKINS

Tea Experiment Station, Mimosa, Mlanje

Senior Tea Research Officer	D. H. LAYCOCK, M.SC. (LEEDS), A.I.C.T.A.
Tea Research Officer	*Vacant*
Horticulturist	I. P. SCARBOROUGH, DIP. HORT.
Farm Manager	G. A. BRIDGER

Bvumbwe Tung and Agricultural Experiment Station, Box 48, *Limbe*

Agricultural Officer	L. J. FOSTER, B.SC. (READING)
Agricultural Chemist	C. V. CUTTING, B.SC. (LOND.), PH.D., A.R.I.C.
Plant Pathologist (Coffee Research) ..	M. A. SIDDIQI, M.SC. (ALIGARH), PH.D. (WALES)
Laboratory Technician	R. C. PEAK
Farm Manager	E. FABIAN, N.D.A., S.D.A.

Tuchila Experiment Station, Box 28, *Luchenza*

Officer in Charge	A. E. PREECE, N.D.A., N.D.D., S.D.A.

Makanga Experiment Station, Chiromo.

Cotton Specialist (E.C.G.C.)	J. M. MUNRO, B.SC. (EDIN.)
Farm Manager	D. F. COLLINGS, C.D.A.

Mwera Hill Experiment Station, Dowa	
Officer in Charge	M. J. Furber, B.Sc. (Reading), Dip. Agric. (Cantab.), D.T.A., (Trin.)
Chitala Experiment Station, Salima	
Officer in Charge	Y. J. Kamponda
Mbawa Experiment Station, Mzimba.	
Officer in Charge	F. Higson
Provincial Agricultural Officers	
Southern Province	J. A. Sandys, B.Sc. (Nottingham)
Central Province	H. W. T. Webb, B.Sc. (McGill), A.I.C.T.A.
Northern Province	J. Evans, B.Sc. (Reading)
Headquarters, Zomba	
Chief Agricultural Research Officer ..	S. T. Hoyle, O.B.E., M.A. (Cantab.), A.I.C.T.A.
Entomologist	G. W. Heath, B.Sc. (Agric.), (Dunelm), Ph.D. (Lond.), M.I.Biol.
Ecologist	G. Jackson, B.Sc. (Hons.) (Sheffield), Dip. Agric. Sc. (Cantab.)
Plant Pathologist	D. C. M. Corbett, B.Sc. (Hons.) (Aberd.), Dip. Agric. Sc. (Cantab), D.T.A. (Trin.)
Soil Surveyor	A. Young, M.A. (Cantab), Ph.D. (Sheffield)
Cotton Pest Research Scheme	
Officer in Charge (Gatooma)	J. P. Tunstall, B.Sc. (Hons.), Dip. Agric. (Reading), A.R.C.S.
Entomologist (Gatooma)	G. A. Matthews, B.Sc., A.R.C.S., F.R.E.S.
Entomologist (Makanga)	R. C. H. Sweeney, M.I.Biol., F.R.E.S.
Technical Assistant (Gatooma) ..	A. A. Rhodes
Technical Assistant	I. Macdonald

MAIZE

Breeding Work

1. GENERAL

The season can be regarded as the most successful one since the maize breeding was initiated. The hybrid Mthenga came up to expectations in trials and on a field scale, and the way now appears clear for its use on a commercial scale. The synthetic variety with resistance to *Puccinia polysora* rust, which has been named Mlonda, showed its field resistance to the disease and also its ability to give high yields of a predominantly flinty type grain. It should find wide use in the hotter areas of the Protectorate. A synthetic variety Asikari, designed for general use in the main maize growing area, outyielded Namalenga appreciably on a field scale. A definite break has been made in the problem; what is required now is extensive field trials and extension work to gain information on the behaviour of these varieties in a wide range of field conditions, the growers' preferences, the feasibility of the use of hybrids and methods of seed production and distribution.

2. INBREEDING

Inbreeding of established lines continued. The most advanced group which grew as S.9 plants, has now been reduced to 138 lines from a maximum number of 822 in the S.3 generation.

3. VARIETY TRIALS

Variety trials were conducted as usual at the five main stations. Plots were of 10 square yards with plants placed singly at 1 foot intervals.

Coefficients of variation were generally lower than is usual on the out-stations. The results are very much as might have been predicted from past experience.

The top yielders are, in general, the group of local hybrids numbers 6 to 15. These are all composed of combinations of local, Southern Rhodesian and Mexican material, with the exception of L.H. No. 10 which is more strictly a top cross between the open pollinated variety Namalenga and a Mexican inbred. L.H. No. 7, Mthenga, was the outstandingly best hybrid in 1957/58 season, and arrangements are being made for its large scale production. It would appear from this season's trials that L.H. No. 11 is rather superior to it in yield and of comparable quality. Only two of the four inbreds of L.H. No. 11 are different from those of L.H. No. 7, and it would be a very easy matter to switch production on to this should further trials support this season's results. In the meantime, L.H. No. 7 is seen to have an overall yield superiority of 40 per cent. over the local unselected maize.

The comparison between Mlonda F.1 and F.2 in these trials, is very unsatisfactory. At Mbawa the F.2 is higher than the F.1; at Chitedze very little different, and at the other stations a considerable drop has taken place. A small drop in yield only was anticipated, and certainly all the bulk plantings of Mlonda F.2 have yielded very well.

The yield of those synthetic varieties grown in F.1 are all high, but these should be taken as preliminary indications only and a drop in the F.2 generation is certain. All the synthetic varieties not specified as F.1 are growing in advanced generations, and their yield can be regarded as stable. Of these S.V. No. 17, Asikari, is the most satisfactory in combination of yield and quality. S.V. No. 13 and Planter are closely related; their yield is good but their quality is unacceptable for general use. The standard open pollinated variety, Namalenga, did rather better than in 1957/58, but is still below the general mean yield.

TABLE 1

Maize Variety Trials

(Yields of grain (lb./acre))

	Variety	Chitedze	Tuchila	Mbawa	Chitala	Makanga	Mean yield	% of local unselected
1.	Local	5,424	2,835	3,214	2,576	2,144	3,238	—
2.	Namalenga	6,160	3,388	3,502	3,512	1,840	3,680	114
3.	S.R. Hybrid No. 8	6,016	3,512	4,768*	3,032	1,960	3,858	119
4.	Local Hybrid No. 2 F.1	6,645	2,843	3,601	3,456	1,896	3,688	114
5.	,, ,, No. 2 F.3	5,849	2,168	2,843	1,960	152	2,714	84
6.	,, ,, No. 6	6,774	3,820	4,449	3,528	—	4,643	132
7.	,, ,, No. 7 Mthenga	7,707*	3,942*	4,321	3,904	2,728	4,520	140
8.	N2 656 × 24 053 / R5 125 × ITC26 No. 9	5,606	2,395	4,457	3,168	—	3,906	111
9.	Na × Mex. 20 No. 10	7,381	3,752	4,252	4,008*	2,584	4,395	130
10.	R5 115 × Mex. 1 / R5 125 × N2 656 No. 11	8,314*	4,518*	4,965*	4,144*	2,848*	4,958	153
11.	R5 155 × Mex. 1 / Mex. 20 × L4 161 No. 12	8,511*	3,472	3,957	3,592	2,720	4,450	137
12.	R5 115 × Mex. 1 / R5 125 × N2 656 No. 13	7,419	3,980*	4,055	3,880*	3,528*	4,572	141
13.	Na × Mex. 20 No. 14	7,533	4,192*	4,935*	3,744*	—	5,101	145
14.	71 × 93 No. 15	5,955	4,017*	5,192*	4,520	3,304*	4,608	142
15.	Synthetic Var. No. 1/2	5,720	2,729	3,494	3,232	1,424	3,320	103
16.	,, ,, No. 7	4,696	2,873	3,411	2,784	1,192	2,991	92
17.	,, ,, No. 8	5,955	2,956	4,093	3,064	1,696	3,553	110
18.	,, ,, No. 10 F.1	6,615	3,767	4,116	4,088*	—	4,646	132
19.	,, ,, No. 12	6,145	2,896	3,585	2,800	1,520	3,389	105
20.	,, ,, No. 13	6,327	3,532	4,002	3,008	—	4,217	120
21.	,, ,, No. 14	5,424	3,024	3,767	3,336	2,640	3,638	112
22.	,, ,, No. 15	6,289	2,812	3,957	3,144	2,192	3,679	114
23.	,, ,, No. 16	6,160	2,789	3,889	3,552	1,760	3,630	112
24.	No. 17 Asikari	6,372	3,002	4,343	3,424	2,144	3,857	119
25.	No. 18 ,,	6,668	2,971	3,972	3,168	1,432	3,642	112
26.	No. 19 Nduna	6,486	2,918	4,290	2,496	1,328	3,504	108
27.	No. 20 Walero	5,636	3,275	3,670	3,576	2,128	3,558	110
28.	No. 21 F.1	7,070	3,403	4,556	3,688	2,864*	4,316	133
29.	F.1 Mlonda	5,818	4,124*	3,623	3,640	2,912*	4,023	124
30.	F.2 ,,	5,720	2,433	3,760	2,800	2,112	3,365	104
31.	Synthetic Var. No. 22 F.1	5,947	—	—	—	—	—	110
32.	,, ,, No. 23 F.1	6,441	—	—	—	—	—	119
33.	West Indian Synthetic	5,932	—	—	—	—	—	109
34.	Mbawa Synthetic	4,764	—	—	—	—	—	88
35.	Good Tip Coverage Synthetic	5,690	—	—	—	—	—	105
36.	Planter	6,820	—	—	—	—	—	126
37.	GTC. × Helminthosporium Resistant SV. 29 F.1	6,797	—	—	—	—	—	125
38.	STCM. × Helminthosporium Resistant SV.30 F.1	6,425	—	—	—	—	—	118
39.	Mlonda × Helminthosporium Resistant SV.31 F.1	6,858	—	—	—	—	—	126
40.	Mkanda × Helminthosporium Resistant SV.32 F.1	5,765	—	—	—	—	—	106
41.	Synthetic Var. No. 24	—	—	—	—	2,416	—	113
42.	,, ,, No. 25	—	—	—	—	2,384	—	111
43.	AFRO. × SC.71. SV.38 F.1	—	—	—	—	3,152*	—	147
44.	,, × SC.93. SV.39 F.1	—	—	—	—	3,456*	—	161
45.	,, × SC.110. SV.40 F.1	—	—	—	—	2,926*	—	136
	Mean	6,326	3,277	4,035	3,352	2,147	—	—
	Least Significant diff.	925	569	584	732	680	—	—
	Coefficient of Varn.	12.6%	15%	12%	19%	26%	—	—

* Top yielding varieties not differing significantly from one another.

In the Annual Reports for 1956/57 and 1957/58, a maize pounding experiment was described which showed that the proportion of usable starchy material coming from a given weight of grain when prepared in the traditional way, varies between varieties. In evaluating the merits of varieties, which we expected to be used primarily by Africans, they should, therefore, be corrected for this factor. A number of varieties which were available in sufficient bulk were pounded by a number of women, and the following values obtained:

TABLE II

Variety	*% Mpale (usable starchy material) of Grain (dry weights)*	*Overall yield in Maize Variety Trial (as % of Local unselected)*	
		Uncorrected	*Corrected for Mpale value*
Local Unselected	77.2	100	100
L.H. No. 7 Mthenga	70.2	140	127
SV. No. 17 Asikari	76.3	119	118
S. Rhodesia Hybrid No. 8	61.5	119	95
SV. 12	70.1	105	95
Namalenga	72.0	114	106
L.H. No. 2 F.1	74.2	114	110

This refinement places the Local Unselected maize in a better light and puts assessments of grain quality on a quantitative basis. It is proposed to extend it to as many treatments and trials as possible in future.

4. DISTRICT MAIZE TRIALS

Following the interest shown by African cultivators in the Maize Variety Observations that they carried out in their gardens during 1957/58, and which were reported last year, seed of four varieties was issued for similar trials in the 1958/59 season. They were to be compared with a fifth plot comprising the growers' own seed. Eleven such trials in Southern Province, nine in Northern Province and 61 in Central Province, were successfully carried through to give yield information. In 19 of the Central Province trials, growers did not plant their own seed in the experiments, but only the four varieties provided. A single replication was planted at each site.

Growers were asked to give an order of preference for the varieties under trial and a number of them did so. A brief description of the varieties tested is as follows:

Mtanda is a double-cross hybrid that gave the highest yield in last year's comparable trials. It has a denty grain, and its tip coverage is not good. Master, also a double-cross hybrid, has harder grain and better tip coverage. Namalenga, an open pollinated selection from Southern Province, had, like Mlonda, been included in the 1957/58 trials. Mlonda is the synthetic, polysora resistant variety that is being bulked for distribution in the lower areas of the country. Results are given in Table III.

TABLE III

District Maize Variety Trials 1958/59

Yield in lb. of Grain per acre

	No. of Trials	Own Seed	Nama-lenga	Mlonda	Master	Mtanda	Least Sig. Diff.
Southern Province ..	11	3,029	3,271	3,079	2,882	3,283	468
Northern Province ..	9	2,424	2,766	2,528	2,486	2,554	381
Central Province ..	42	2,973	3,417	3,488	3,429	3,715	262
Four Varities only ..	19	—	4,372	4,451	5,240	5,109	508
MEAN		2,808	3,456	3,386	3,509	3,665	

Preferences Expressed by Growers

Number of times a Variety was Placed 1st or 2nd

	No. of trials in which preference was stated	Own Seed	Nama-lenga	Mlonda	Master	Mtanda
Southern Province	7	1	6	4	1	2
Central Province	40	4	24	10	32	10
TOTAL ..	—	5	30	14	33	12

N.B. No preferences were given from Northern Province.

Considering the trials over the whole country, the order of yields generally confirms the results of the formal trials on experimental stations. In Central Province, where the number of trials was approximately six times greater than in the other Provinces, this is most clearly brought out.

Mtanda, on average the highest yielder, was not the best liked by the growers, and Master, which approached closest to it in yield and exceeded it in some groups of trials, was more popular on account of its harder grain and better tip coverage which was specifically commented on by most growers. Namalenga remained particularly popular in Southern Province. Mlonda continued to perform satisfactorily.

5. SYNTHETIC VARIETIES TRIAL

As has been seen above, it is possible to produce synthetic varieties with high first generation (F.1) yields, but as it is intended that the seed of such varieties should be grown on from year to year, the yield in the second (F.2) and subsequent generations (F.3, etc.) is a critical factor. The yields of particular combinations vary according to the manner in which the component lines combine with one another. In general, however, it is much easier to find a few lines (4) which will combine well together to give a high F.1 yield, than it is to find many (12). However, the greater the number of component lines the less will be the drop in the F.2 and subsequent generations. According to genetical theory with maize, there will be a big drop in hybrid vigour, and thus also productivity in the F.2 generation, according to the formula:

$$\text{F.2 Yield} = \text{F.1 yield} - \left\{ \frac{\text{F.1 yield} - \text{average yield of parents}}{\text{number of parents}} \right\}$$

but there will be no further drop in F.3 or subsequent generations.

A trial was carried out with as many synthetic varieties and hybrids as were available to obtain as much confirmatory information as possible on this important matter. The results which are given below, confirm the theoretical considerations. Similar results were obtained and reported in the Annual Report for 1956/57.

TABLE IV

Synthetic Varieties Trial

Yields in lb. grain acre

No. of Component Lines								
24	..	Synthetic Variety	..	1/2	..	F.1	..	5,530
		,, ,,	..	,,	..	F.2	..	5,844
4	..	,, ,,	..	6	..	F.1	..	5,288
		,, ,,	..	,,	..	F.2	..	4,840
8	..	,, ,,	..	7	..	F.1	..	5,094
		,, ,,	..	,,	..	F.2	..	4,949
		,, ,,	..	,,	..	F.3	..	4,937
30	..	,, ,,	..	8	..	F.2	..	6,994
		,, ,,	..	,,	..	F.3	..	6,570
8	..	,, ,,	..	12	..	F.1	..	6,534
		,, ,,	..	,,	..	F.2	..	5,784
30	..	,, ,,	..	13	..	F.2	..	5,118
	..	,, ,,	..	,,	..	F.3	..	6,183
80	..	,, ,,	..	14	..	F.1	..	5,990
	..	,, ,,	..	,,	..	F.2	..	5,300
50	..	,, ,,	..	15	..	F.1	..	5,457
	..	,, ,,	..	,,	..	F.2	..	5,578
40	..	,, ,,	..	16	..	F.1	..	5,953
	..	,, ,,	..	,,	..	F.2	..	5,639
28	..	,, ,,	..	17	..	F.1	..	6,050
	..	,, ,,	..	,,	..	F.2	..	5,880
50	..	,, ,,	..	18	..	F.1	..	5,481
	..	,, ,,	..	,,	..	F.2	..	5,530
12	..	,, ,,	..	19	..	F.1	..	5,505
	..	,, ,,	..	,,	..	F.2	..	6,014
9	..	,, ,,	Mlonda		..	F.1	..	5,530
	..	,, ,,	..	,,	..	F.2	..	5,070
34	..	,, ,,	Good Tip		..	F.1	..	4,634
	..	,, ,,	..	,,	..	F.2	..	5,130
4	..	Local Hybrid No. 2	..	—	..	F.1	..	5,469
	..	,, ,, ,,	..		..	F.2	..	4,453
	..	,, ,, ,,	..		..	F.3	..	4,888
4	..	,, ,, No. 7	..		..	F.1	..	7,514
	..	,, ,, ,,	..		..	F.2 (calculated)		6,724
		Local Unselected	..	—	..	—	..	4,731
		Mean	..	—	..	—	..	5,526
		Least significant difference		—	..	—	..	1,053
		Coefficient of Variation		—	..	—	..	14%

6. HYBRIDS YIELD TRIAL AND THE DEVELOPMENT OF NEW HYBRIDS

This was a very large trial of 156 treatments which included double and single cross hybrids between local and introduced material, and of local material only, and also a number of inbred lines grown as such. The trial occupied an area of almost one acre, and despite the wide range of the entries, the mean yield was 5,498 lb. grain per acre. The trial confirmed the value of the inbred lines (Local) L.4161, R5125, R5115 (Mexican), SLP20.66B, H501 and (S. Rhod.) N2656, but also indicated a number of new local inbred lines which combined well with N2656.

The two Mexican lines, and that from Southern Rhodesia, are of great value in that they combine with many local inbreds to give hybrids which can be used to make

double cross hybrids of high yield and acceptable quality. The quality—degree of hardness of the grain and tip coverage of the cob—could be bettered, however, and future work must be directed towards the development of hybrids of equal yield, but better quality than those available at present.

With this object in view the new local lines discovered by this trial and a number of others, are being crossed at Chitala under irrigation during the 1959 dry season, and will be tested in 1959/60.

7. BREEDING FOR DISEASE RESISTANCE

There was a moderately heavy attack of *Helminthosporium turcicum* leaf blight at the Agricultural Research Station, Lilongwe, but resistant strains maintained their resistance as expected. A fresh series of crosses was made between resistant material and certain Synthetic Varieties in the hope of improving the resistance of these latter.

Puccinia polysora rust was again severe in the lower-lying areas of the Protectorate, and was recorded in a moderately heavy attack at Chitala station on the Salima Lake-shore. Much interest centred on the performance of the synthetic variety Mlonda. On a number of field sites in conditions of severe infection, this showed the predicted ratios of three-quarters resistant plants to one-quarter susceptible. Recorded yields were high and satisfaction with the pounding quality of this variety was expressed by African growers. Mlonda is being bulked at the Agricultural Production and Marketing Board Farm at Balaka, and there seems to be every prospect of it being very popular and useful in the low altitude areas.

Trials to assess the loss in yield of maize caused by disease were carried out at Chitedze and Makanga. In neither case were significant results obtained.

8. EXTRACT FROM THE REPORT OF THE OFFICER-IN-CHARGE OF THE TUNG STATION

Variety Observations

A better variety than Namalenga is required for the Mixed Farm at Bvumbwe. Although no formal variety trial was planted, observation plots showed that we could expect about five bags an acre more from the hybrid variety Mtenga than any other white maize; other varieties produced from 16 to 22 bags per acre and Mtenga gave 27 bags. Mtenga produces a strong stem, not subject to lodging, and large cobs, with a high shelling-out percentage, well covered by the sheath.

The yellow variety Sahara was promising, giving 24 to 25 bags per acre and has a use on the farm for livestock.

Maize Agronomy

FERTILIZER TRIALS

1. FEDERAL FERTILIZER TRIAL

The object of this series of trials was to test the suitability of the methods used by the Soil Science Laboratory in Salisbury, for determining fertilizer recommendations for soils under Nyasaland conditions. Six sites were chosen as shown in the table below, and the soil samples taken were analysed both in the laboratories of the Nyasaland Department of Agriculture and in those of the Federal Department in Salisbury. The Soils Department in Salisbury was good enough to make recommendations on the samples and data supplied to them, and these were tested by conducting a 4 × 4 factorial nitrogen and phosphate trial at each site. The treatments were confounded to give two blocks of eight plots per replication, and there were three replications.

TABLE V

Results of Federal Fertilizer Trial—Responses to Nitrogen and Phosphate

Variety: Local Selections *Yields: in lb. per acre grain*

Station	*Chitedze*	*Chitala*	*Mbawa*	*Tuchila*	*Tung Station*	*Makanga*
Soil Type	S.C.L.	S.C.L.	S.C.L.	S.C.	S.C.L.	Alluvium
pH	5.9	6.3	6.1	5.5	6.2	6.4
Total Nitrogen Percentage	.118	.083	.072	.054	.137	.151
Total incubated N. ppm.	34	31	25	98 (48)	61	46
Mineral N. released on incubation ppm. ..	23	15	14	48 (10)	41	19
Recommendations lb. Nitrogen ..	50-60	60–70	80–90	Nil	20	30-40
Experimental treatments						
N_0 Nil	4,134	2,146	1,781	1,922	2,818	2,833
N_1 31 lb. N/A ..	4,248	3,054***	2,570***	2,687***	2,740	3,100
N_2 62 lb. N/A ..	4,443	3,590***	3,633***	3,187***	2,575	2,817
N_3 93 lb. N/A ..	4,561	3,892***	4,081***	3,254***	2,505	2,678
Available P. (NaOH) ppm.	41	34	89	62	132	190
Recommendations lb. P_2O_5	40	60	Nil	20	Nil	Nil
Experimental treatments						
P_0 Nil	3,748	2,902	2,827	2,800	2,733	3,005
P_1 19 lb. P_2O_5 ..	4,201*	3,259**	2,980	2,805	2,630	2,593
P_2 38 lb. P_2O_5 ..	4,635***	3,297**	3,186	2,747	2,646	2,988
P_3 57 lb. P_2O_5 ..	4,803***	3,224**	3,073	2,697	2,628	2,842
L.S.D.	365	197	371	367	282	332
Mean	4,347	3,170	3,016	2,762	2,659	2,857
Coef. Varn.	12.7%	5.8%	11.4%	12.9%	12.7%	11.0%

N.B. The figures for incubated nitrogen are those given by Salisbury. Those obtained at Bvumbwe agreed well except at Tuchila, where the Bvumbwe figures (given in brackets) reflect the fertilizer response very much better than the Salisbury ones.

Nitrogen was applied as sulphate of ammonia (21% N.) and phosphate was applied as single superphosphate (19% P_2O_5).

It would appear that the methods used and factors taken into consideration when making fertilizer recommendations for Southern Rhodesia do not apply exactly in Nyasaland. Threshold values of soil nitrogen and phosphate have been worked out which will divide, with a fair degree of certainty, those soils which will give economic responses from those which will not, but it is evident that many other factors of environment must be considered when trying to estimate optimum rates of fertilizer application from soil data. (*See* Ann. Rep. 1957/58.)

2. TIME OF APPLICATION OF NITROGEN

The object of this trial was to determine the best time of application of sulphate of ammonia to maize within the range of dressings likely to be applicable to African agriculture. Four sites were chosen as shown below, and the experiment designed as a 2 × 5 factorial with one control plot (no fertilizer) per block, replicated four times. The treatments were 200 and 400 lb. per acre of sulphate of ammonia applied:

(*a*) all at planting

(*b*) all at 30 days

(*c*) half at planting and half at 30 days

(*d*) one quarter at planting, half at 30 days and one quarter at tasselling, and

(*e*) half at planting, one quarter at 30 days and one quarter at tasselling.

TABLE VI

Effect of Time of Application of Nitrogen on Maize Yields

Variety: Local Selections *Yields lb./acre grain*

Station	*Chitedze*	*Chitala*	*Tuchila*	*Mbawa*
Soil Type	S.C.L.	S.C.L.	S.C.	S.C.L.
Sulphate of Ammonia:				
N_0 Nil	3,174	2,520	2,282	1,603
N_1 200 lb. per acre	3,478	3,781***	3,298***	3,332***
N_2 400 lb. per acre	3,339	4,436***	3,522***	4,158***
L.S.D. 5% (N_1 v N_2) ..	191	246	157	217
Applied at:				
(*a*) Planting	3,232	4,172	2,994	3,971***
(*b*) 30 days	3,475	4,049	3,486	2,816
(*c*) half planting, half 30 days ..	3,417	4,025	3,542	3,915
(*d*) quarter planting, half 30 days, quarter tasselling ..	3,240	4,123	3,585 ***	3,919 ***
(*e*) half planting, quarter 30 days, quarter tasselling ..	3,592	4,174	3,441	4,105
L.S.D. 5%	302	388	248	344
Mean	3,330	3,963	3,034	3,550
Coef. of Varn.	8.8%	9.6%	7.3%	9.5%

The best time to apply a single dressing appears to vary from place to place, at planting being best at Mbawa, and at thirty days best at Tuchila, while it made little difference at which of these dates it was applied at Chitedze and Chitala. It is not worth splitting the dressing into more than two parts, one of which should go on at planting and one at thirty days. These results corroborate those found last year, except that the trends shown markedly at Tuchila and Mbawa this year were not significant last year.

3. 25/10/0 FERTILIZER MIXTURE

This trial was conducted to see how a new high analysis NP fertilizer mixture compared with equivalent sulphate of ammonia and superphosphate. The experiment was conducted at four sites as shown below, and designed as a 2×3 factorial with one control plot (no fertilizer) in each block; replicated four times. The treatments were the three types of fertilizer:

(*a*) 25/10/0 mixture

(*b*) Sulphate of ammonia and superphosphate equivalent (*a*)

(*c*) Sulphate of ammonia alone. Treatments (*b*) and (*c*) provide the same levels of N and P as does the 25/10/0 mixture.

TABLE VII

Response of maize to 25/10/0 Mixture and equivalent straight Fertilizers

Variety: Local Selections *Yields: lb. per acre grain*

Station	*Chitedze*	*Chitala*	*Tuchila*	*Mbawa*
Soil	S.C.L.	S.C.L.	S.C.	S.C.L.
Total N%	.174	.123	.096	.084
Available P p.p.m.	34	34	31	111
(*a*) 25/10/0	3,854**	2,851	3,032	1,959
(*b*) S/A+Supers	3,960***	3,217*	3,091	2,336**
(*c*) S/A alone	3,268	3,031	2,897	2,349**
L.S.D. 5%	330	265	326	219
Nil	3,272	2,073	1,538	1,109
25 lb. per acre N	3,552*	2,915***	2,716***	1,893***
50 lb. ,, ,, N	3,837**	3,151***	3,298***	2,535***
L.S.D. 5%	270	216	268	179
Mean	3,554	2,895	2,797	2,052
Coef. of Varn.	8.8%	8.6%	11.1%	10.1%

The new mixture was as effective as equivalent sulphate of ammonia plus superphosphate at Chitedze, where nitrogen and phosphate were both in short supply. At Tuchila, where no responses to phosphate are obtained—as in most of the Southern Province it was not significantly better than sulphate of ammonia alone. On certain soils at Mbawa there is a marked sulphur deficiency which may account for the mixture being poorer than the other fertilizers, both of which contain appreciable amounts of sulphur. The mixture contains very little sulphur and is deliquescent. It is granular and very easy to handle when freshly taken from an undamaged bag (polythene lined), but it does not store well when exposed to a damp atmosphere.

4. TYPES OF NITROGEN TRIALS

On three sites at Chitedze on chocolate sandy clay loams, sulphate of ammonia, urea, nitrate of soda and nitromonical were compared in a randomized block design, to see which was the most efficient source of nitrogen for single application in dollops to maize after the first weeding. On two sites there were no significant responses to nitrogen, though nitromoncal in both cases gave the smallest increases. On the third site only sulphate of ammonia and nitrate of soda were compared, the former giving the better responses per lb. of nitrogen applied. It appears that for general use on maize, sulphate of ammonia or urea are to be preferred to nitrate of soda and nitromonical. In addition, both of the latter tend to deliquescence.

5. TYPES OF PHOSPHATE TRIAL

On a highly phosphate deficient red sandy soil at Mbawa (available P_2O_5 18 p.p.m.) the following treatments were applied in a randomized block design to see how best to correct the phosphate deficiency. Treatments were:

(*a*) no phosphate

(*b*) 200 lb. per acre raw rock phosphate

(*c*) 400 lb. per acre raw rock phosphate

(*d*) 200 lb. per acre single superphosphate

(*e*) 85 lb. per acre single superphosphate

(*f*) 200 lb. per acre of the 25/10/0 mixture.

All the phosphates were applied in a band under the ridge on 28th November before planting and the 25/10/0 mixture was applied as a top dressing in dollops ten days after planting. At the same time all other plots were top dressed with sulphate of ammonia giving a nitrogen application equivalent to that in (*f*). All yields were very low, control yield being 750 lb. per acre, and the coefficient of variation at 20.9 per cent. was high. The raw rock phosphate did not increase the yields at all, evidently not becoming available in the season of application. The 25/10/0 mixture gave an unsignificant increase of 300 lb. per acre grain over the control, the phosphate being available, but applied rather late. Only the single and triple superphosphate had the desired effect, both of them being equally efficient in raising the yields by 1,150 lb. to the 1,900 lb. per acre mark. The L.S.D. 5 per cent. was 350 lb. per acre grain.

The experiment will be continued to test the residual effects of the dressings.

6. DISTRICT FERTILIZER TRIALS

Thirty-eight district trials were successfully completed in the past season, 13 in the Northern Province, 19 in the Central Province and 6 in the Southern Province, thus increasing to 105 the number of trials from which it is hoped to obtain response curves to nitrogen and phosphate for various soil types in the agroecological regions of Nyasaland. The trials are of a 3 × 3 design with two replications where responses to both nitrogen and phosphate are expected, largely in the Northern Province, and 3 × 2 design with four replications where phosphate is not likely to be limiting—Central and Southern Provinces. Levels of fertilizer used are N_0=nil, N_1=100 lb. per acre S/A, N_2=200 lb. per acre S/A, and P_0=nil, P_1=200 lb. per acre supers, P_2 (3 × 3 only)=400 lb. per acre supers. Coefficients of Variation for these experiments ranged from 5.7 per cent. to 33.6 per cent., but only 9 of the 38 were over 20.0 per cent. and 12 were under 10 per cent.

No phosphate responses were obtained in the Southern Province, but there were significant increases obtained at Chitedze on land newly ploughed from a fairly heavily utilized but unfertilized Rhodes grass ley, and on certain soil types in the Northern Province stretching from the Chimaliro hills, up the Rukuru Valley, through the western foot hills of the Nyika to the hill areas of Karonga. Further experiments are needed and are being planned to delimit these phosphate deficient soils more exactly. Where there is a response to phosphate, 200 lb. per acre supers appears to be the optimum dressing.

Responses to nitrogen were general except (1) on recent alluvial soils, (2) on certain very poor red soils in Fort Manning District and (3) on the majority of Instructors' gardens in the Lilongwe area, where the maize crop followed tobacco which received manure and fertilizer and control yields were of the order of 20 bags per acre grain.

The revised table of calculated response curves to sulphate of ammonia is given below for various soil types and agroecological regions. This supersedes the table given on page 14 of the 1957/58 Report.

TABLE VIII

Calculated Response Curves for Applied Nitrogen on Various Soils

Variety: Local *Yields: lb. per acre grain*

Area and Soil Type	*No. of Expts.*	*Increases due to levels of sulphate of ammonia given in lb./acre at head of table*						*Mean control yield*
		50	100	150	200	250	300	
Northern Province								
Mzimba (East) S.C.L. ..	4	**360**	**647**	**875**	**1,053**	1,203	1,318	1,442
Mzimba (S.W. & W.) S.L. ..	3	**569**	**1,012**	**1,352**	**1,619**	**1,825**	**1,985**	1,869
Mzimba (S.W. & W.) L.S. and S.	4	**425**	**824**	**1,184**	**1,518**	**1,825**	**2,110**	1,109
Mzimba (Dimba) C.L. ..	1	**562**	**772**	**830**	834	842	848	2,475
Rumpi—Various Soils Katowo to Nchenachena ..	7	**328**	**611**	**854**	**1,060**	1,237	1,386	2,737
Karonga Lake-shore ..	5	No response at all						2,064
Karonga Hill Area S.C.L. (Heavy)	2	**450**	**852**	**1,212**	**1,533**	**1,820**	**2,068**	2,445
Karonga Hill Area S.L. & L.S. (Light)	2	**475**	**837**	**1,117**	**1,331**	**1,499**	**1,629**	1,803
Nkata Bay Lake-shore ..	1	**400**	**800**	**1,200**	**1,600**	**2,000**	**2,400**	1,885
Central Province								
Lilongwe/Dowa Plateau red S.C.L. N>.12% ..	16	198	365	535	622	725	812	3,254
Lilongwe/Dowa Plateau red S.C.L. N<.12% ..	8	**291**	**550**	**700**	**1,039**	**1,260**	**1,467**	2,033
Lilongwe/Dowa Plateau Grey brown S.L. N>.10%	6	242	421	553	651	724	777	2,593
Lilongwe/Dowa Plateau Grey brown S.L. N<.10%	6	**250**	**500**	**750**	**1,000**	**1,250**	**1,500**	2,560
Dowa/Dedza Lake-shore C. and S.C. (Heavy)	2	**429**	**762**	**1,025**	**1,229**	**1,390**	**1,513**	947
Dowa/Dedza Lake-shore S.L. (Light)	4	**437**	**740**	**947**	**1,090**	1,189	1,258	1,152
Dedza Highlands	2	265	486	664	808	923	1,019	801
Kasungu S.L. & L.S. ..	3	**350**	**700**	**1,050**	**1,400**	**1,750**	**2,100**	708
Kasungu (Chimaliro) S.C.L. ..	1	**690**	**1,248**	**1,702**	**2,072**	**2,374**	**2,622**	1,912
Fort Manning Red. S.C.L. (Worked out)	2	No response at all						1,566
Fort Manning S.L. & L.S. ..	2	**464**	**836**	**1,137**	**1,378**	**1,571**	**1,726**	1,746
Southern Province								
S. Mlanje foothills	1	130	260	390	520	650	780	1,781
Palombe Plain S.L. & L.S. ..	5	**518**	**952**	**1,340**	**1,670**	**1,958**	**2,545**	1,783
Shire Highlands Mpemba to Domasi ..	4	**327**	**626**	**906**	**1,172**	**1,419**	**1,642**	2,103
Shire Valley Fort Johnston to Kuntaja	6	**356**	**611**	**788**	915	1,002	1,065	2,358
Lower River Heavy alkaline to neutral soils, e.g., Makanga ..	4	No response at all						—
Lower River, Sands e.g., Nkudzi	1	**469**	**827**	**1,100**	**1,308**	**1,468**	**1,589**	1,336

N.B. The bold figures show the range of levels likely to prove economic at present prices.

7. GREEN MANURE TRIALS

The object of this series of experiments is to determine the best variety of green manure crop, when it should be planted, and at what age it should be dug in. Three experiments were completed in 1958/59 season with a test crop of maize, and four others were taken through their first year. The design of the experiments at Chitedze and Tuchila was a $3 \times 3 \times 3$ factorial in a single replication, confounded to give three blocks of nine plots, while that at Chitala was a $2 \times 2 \times 2$ factorial with the second

order interaction confounded to give two blocks to each of the three replications. In every block there was a control plot of groundnuts in the year the green manures were grown. The treatments applied in the first year were three varieties of green manure, V_1 sunnhemp, V_2 velvet bean and V_3 soya (only the first two at Chitala); three times of planting, P_1 early December, P_2 end of December, and P_3 mid-January (only P_2 and P_3 at Chitala); and three times and methods of ploughing in, D_1 at two months old and plant a catch crop, D_2 at two months old with no catch crop, and D_3 at three months old (only D_2 and D_3 at Chitala). The second year a maize crop was grown over the whole area to test the effectiveness of the treatments. No fertilizer was applied. The catch crops of beans and sweet potatoes yielded very little, the later planted ones failing completely.

TABLE IX

Effects of Various Green Manure Treatments on Maize Yields

Variety: Local Selections *Yields: lb./acre grain*

Station	*Chitedze*		*Tuchila*		*Chitala*	
	Maize	G.M.*	Maize	G.M.*	Maize	G.M.*
Groundnuts	3,366	—	2,461	—	3,060	—
Sunnhemp	3,973**	(9.5)	2,893**	(10.2)	3,648	(5.8)
Velvet Bean	3,598*	(5.1)	2,752**	(9.2)	3,454	(3.0)
Soya	2,925	(.3)	2,204	(1.5)	—	—
Planted early Dec. ..	3,399	(6.5)	2,513	(7.9)	—	—
,, end ,, ..	3,565	(5.2)	2,748	(8.3)	3,444	(6.2)
,, mid Jan. ..	3,561	(3.2)	2,588	(4.7)	3,657	(2.7)
Dug two months—catch crop	3,500	(4.9)	2,512	(5.2)	—	—
,, ,, ,, —fallow ..	3,415	(5.0)	2,565	(5.1)	3,695	(4.9)
,, three ,, — ,, ..	3,580	(4.9)	2,772	(10.6)	3,406	(3.9)
L.S.D. 5%	453	(2.0)	356	(2.8)	462	—
Mean	3,498	—	2,616	—	3,345	—
Coef. of Variation ..	11.2%		11.7%		16.0%	

* Figures in brackets are green material turned in the previous year. Given in tons per acre.

Although there were some marked differences in the first year in the amount of material turned in, there are no significant differences in the subsequent maize yields, except where soya bean is included. The medium term variety of soya used is of no use as a green manure, though some tall-growing, later-maturing varieties may be more suitable. The green manures were turned in by hand, being laid in rows and covered to give large ridges 6 feet wide. Under the conditions of these experiments the actual time and method of growing and turning in the green manure do not seem critical, though it must be noted that the groundnut control crop gave yields of maize following it of only two bags per acre less.

Extract from Report of the Agricultural Chemist, Bvumbwe

(*a*) RESPONSE OF NITROGEN ON MONTMONORILLONITIC SOILS AT MAKANGA

The possibility of a micro-nutrient factor being involved in this problem, as discussed in the 1957/58 Report, was examined by spraying an area of irrigated maize with a mixture of micro-nutrients. The solution used contained 4 lb. each of the sulphates of copper, manganese, zinc, iron and aluminium, 4 lb. of magnesium chloride, 2 lb. of sodium molybdate, and $\frac{1}{2}$ lb. of borax, in each 100 gallons. In formulating this, a balance has to be kept between the higher amounts of each element that should be applied, and the effect, as regards scorching, of the total salt concentration. 20 oz. of lime were added to each 100 gallons, but some scorching was produced, although any adverse effect of this was not appreciable. This solution was sprayed at three rates, and the composition of leaf samples, taken before spraying, and then from the new growth after the spray had been applied, was as follows:

TABLE X
Leaf Composition

	ppm.				
	Al	*Cu*	*Fe*	*Mn*	*Zn*
Before Spraying 31/7	270	8.4	127	72	20
After Spraying					
Control	220–290	7–10	116–164	38–60	12–16
Sprayed 50 galls/acre	270	8.4	166	36	29
,, 100 ,, ,, ...	380	11.2	140	42	31
,, 200 ,, ,, ...	210	10.2	132	32	35

The sample of leaf taken before spraying contained 3.4 per cent. N, 0.38 per cent. P, 2.1 per cent. K and 0.26 per cent. magnesium, and would not appear deficient in these nutrients. Similarly, the initial boron content was 12 p.p.m.

After spraying, the only marked increase appears in the zinc content. No effect of the spraying on cob weight or numbers, or total yield, was noted.

(*b*) FEDERAL MAIZE TRIALS

This trial, reported above, was utilized to assess the validity of fertilizer requirements made on the basis of nitrifiable nitrogen, and available phosphate data. The criteria for the forecasts were those established in Southern Rhodesia. A further point examined was the acidifying action of ammonium sulphate on the soil, and whether it would adversely affect the productivity. Application of both ammonium sulphate and nitromonical being made at Tuchila. Additional data on soils and leaf samples from the three Southern Province sites, is summarized below:

Bvumbwe S.C.L. NO_3—after incubation 58 ppm. P (NH_4F) 132 P (Truog) 72 P (hot NaOH) 514

Treatment	*pH*	*Leaf Wt. gms.*	*Ash*	*N*	*P*	*K*	*Ca*	*Mg*
N_0P_0	5.4	3.1	7.4	2.69	.40	1.04	.37	.33
N_2P_0	5.1	4.1	7.5	2.99	.41	1.06	.41	.29
N_3P_0	5.0	3.6	8.1	3.22	.39	1.27	.48	.27
N_2P_2	5.2	3.8	8.4	3.15	.40	1.08	.45	.33
N_3P_2	5.0	3.7	7.3	3.33	.42	1.16	.50	.26
N_3P_3	5.2	4.3	7.8	3.31	.42	1.08	.52	.33

Makanga S.C.L. NO_3—after incubation 54 ppm. P (NH_4F) 163 P (Truog) 301 P (hot NaOH)

Treatment	*pH*	*Leaf Wt. gms.*	*Ash*	*N*	*P*	*K*	*Ca*	*Mg*
N_0P_0	6.0	3.7	17.0	2.18	.25	1.25	.88	.12
N_2P_0	5.3	3.9	17.0	2.25	.24	1.00	.84	.19
N_3P_0	5.1	4.2	17.6	2.41	.27	1.08	.70	.12
N_2P_2	5.3	3.6	18.2	2.18	.21	1.37	.87	.14
N_3P_2	5.2	4.1	17.9	2.45	.25	1.32	.78	.24
N_3P_3	5.1	3.1	15.6	2.30	.24	1.29	.71	.23

Tuchila S.L. NO_3—after incubation 48 ppm. P (NH_4F) 62 P (Truog) 28 P (hot NaOH) 255

Treatment	*pH*	*Leaf Wt. gms.*	*Ash*	*N*	*P*	*K*	*Ca*	*Mg*
N_0P_0	5.6	2.2	8.7	1.85	.26	1.06	.72	.26
	5.6	3.0	8.6	1.79	.27	.91	.67	.23
N_2P_0	4.9	4.0	10.0	2.27	.24	1.02	.73	.32
	5.6	3.1	9.1	2.06	.30	.95	.69	.26
N_3P_0	4.8	3.4	9.1	2.19	.17	1.01	.75	.25
	5.9	3.9	9.3	2.07	.20	1.02	.79	.21
N_2P_2	4.8	4.1	10.1	2.15	.24	1.11	.73	.24
	5.6	4.1	9.3	2.10	.23	1.10	.69	.23
N_3P_3	4.8	3.9	10.5	2.33	.25	1.15	.74	.17
	5.4	3.6	9.7	2.45	.28	1.07	.77	.22

The pH figures given are those for the soil immediately around the plant. Samples taken between plants showed that very little change had occurred, and thus the effect of the fertilizer would appear to be quite localized, and on ploughing the final effect may not be very great. Because of this, the depletion of calcium as indicated in the plots receiving S/A only, and no supers, may not in effect, be as serious as suggested by the figures. The extent of depletion would appear to be most in the lighter soils of Tuchila, about 50 per cent. of the calcium being lost, although the effect on the magnesium is not so marked. Comparison of the Tuchila data is, however, complicated because the experiment covered a range of soil types—as indicated by the base capacity of the N_0P_0 plots. Some variation in soil was also noted at Makanga, the base capacities varying from 21–30. The effect on calcium content was, of course, less noticeable on these soils.

At Tuchila the use of sulphate of ammonia gave higher yields than did the neutral fertilizer in spite of the effects on calcium and pH close to the plants.

The leaf analysis does not reflect the depletion of calcium which occurs in the soil, the plant apparently getting all it requires. The effect of nitrogen was seen in the generally larger leaf, as well as in its higher content of nitrogen; it is interesting to see that both these effects were less marked at Makanga. The potassium content did not appear to be affected, and was similar at all stations.

The leaf phosphate was highest at Bvumbwe, and only at Tuchila is the leaf content markedly affected by fertilizers, the N_3P_0 treatment producing a decrease in leaf phosphate. However, though this would suggest that P might be a limiting factor, no significant responses were obtained with this fertilizer.

Regarding the fertilizer forecasting it would therefore appear that where conditions are similar to those of Rhodesia, i.e., soils of low N in conditions of lower rainfall, the incubation data does not appear completely invalid, when one considers the few sites on which an assessment was made.

For higher N contents, Nyasaland levels will have to be decided, just as is done for flue-cured tobacco on heavier soils of higher N content; the Salisbury criteria only applying on light soils of low N content.

Similarly, with phosphate, Nyasaland levels are generally much higher than those of Rhodesian soils (usually 50 p.p.m.). Where soils of lower phosphate level are encountered here, the Salisbury criteria seem valid, and the ammonium fluoride method also gives reasonable results.

For any more definite conclusions more experiments need to be made, on sites where the soils are definitely in the responsive range.

Maize Cultivation Trials

1. MAIZE POPULATION TRIALS

Three trials, which bear upon this subject, were conducted at Chitedze on red-brown sandy clay loam of the Ngongonda series.

(*a*) The object of the first trial was to determine the effect of missing hills in a population which, if perfect, should be spaced on ridges 3 feet apart, with hills 3 feet apart on the ridge and three plants per hill. The design was a randomized block experiment with five replications of twelve treatments, each plot being one row 20 yards length. The treatments were as follows:

Four seeds were planted at every hill and the treatments were obtained by cutting out hills or plants.

(1) 14,520 plants/acre—made up of hills containing 1, 2, 3 or 4 plants.
(2) 14,520 plants/acre—full stand, all hills with 3 plants.
(3) ,, ,, —4 plants per hill and five single hills missing.
(4) ,, ,, —4 plants per hill, and two pairs of hills and one single hill missing.
(5) 11,620 ,, —made up of hills containing 1, 2, 3, or 4 plants.
(6) ,, ,, —3 plants per hill, and 4 single hills missing.
(7) ,, ,, —3 plants per hill and two pairs of hills missing.
(8) ,, ,, —3 plants per hill, and 4 hills in a row missing.
(9) 8,710 ,, —made up of hills containing 1, 2, 3 or 4 plants.
(10) ,, ,, —3 plants per hill, and eight single hills missing.
(11) ,, ,, —3 plants per hill, and four pairs of hills missing.
(12) ,, ,, —3 plants per hill, and two lots of 4 hills missing.

TABLE XI

Effect of Plant Population and Missing Hills on Maize yields

Variety: Namalenga *Yields: lb. per acre grain*

Treatment	*Yield*	*Treatment*	*Yield*
14,520 plants/acre	3,445***	No hills missing, 1 to 4 plants/hill	3,525***
11,620 ,, ,, ...	3,008***	Single hills missing ..	2,849
8,710 ,, ,, ...	2,557	Pairs of hills missing ..	2,835
		4 hills in a row missing ..	2,576
L.S.D. 5%	277	L.S.D. 5%	319

Mean .. .. 3,003 lb. per acre Coef. Varn. 14.4%

(*b*) The object of the second small trial was to test the effect of planting more than three seeds per hill without supplying or thinning. The design was a randomized block experiment with the three treatments (3, 4 or 5 seeds planted) replicated eight times. Yields were poor and there was much lodging caused by ants and wind in this experiment.

TABLE XII

Effect of Plant Population on Maize Yields

Variety: Namalenga *Yields: lb. per acre grain*

Treatment	*Yield*	*Plants/acre at Harvest*	*Cobs/acre*	*lb./Cob.*
Plant 3 seeds	2,382	12,640	9,710	.341
Plant 4 seeds	2,520	16,030	12,250	.286
Plant 5 seeds	2,483	19,780	13,280	.260

L.S.D. 5% 401 Coef. of Varn. 15.3% Mean 2,462

(*c*) The third experiment was to measure the effect of thinning and supplying on stands obtained by planting 3, 4 and 5 seeds per hill. Thinning consisted of removing surplus plants where there were more than 3 per hill, and was, therefore, a dummy treatment where 3 seeds only per hill, were planted. Supplying consisted of sowing the number of seeds needed to bring the number of plants per hill germinated to the treatment figure of 3, 4 or 5. The design was a $2 \times 2 \times 3$ factorial in 10 replications.

TABLE XIII

Effect of Thinning and Supplying on Maize Population and Yield

Varieties: Synthetic Varieties 6 and 16 Yields: lb. per acre grain Population: plants/acre

Treatment	Not thinned Yields	Thinned Yields	Not thinned Population	Thinned Population
3 seeds	2,693		13,330	
4 ,, ...	2,754	2,944	16,990	13,660
5 ,, ...	2,646	2,984	21,190	14,340

L.S.D. 5% .. 226 Coef. Varn. 12.8% Mean 2,785

Supplying had no effect on yield and increased the population from 88.4 per cent. of theoretical total to 97.2 per cent. of theoretical total

From these experiments it would appear that the optimum population for Chitedze conditions is 13,000–14,000 plants per acre, and that where the population is planted in hills, no complete hills should be missing. Thinning is unimportant unless more than four plants per hill have germinated. To obtain this stand, 3 or 4 seeds, depending on the viability of the seed, should be planted per hill at 3 ft. × 3 ft. spacing, and any complete hills found missing should be resown within a week of the first seedling appearing above ground.

2. DISTRICT POPULATION AND NITROGEN TRIALS

Two of these experiments were conducted on poor soils at Namizana and Kasungu to see whether better yields and cobs could be obtained from a population lower than that given by the standard 3×3×3 spacing, and to test the interaction of nitrogen and population under these conditions. The soils had previously shown no response to phosphate. The design was a 3×3 factorial with two replications; the treatments 0, 100 and 200 lb. per acre, sulphate of ammonia, and 1, 2 and 3 plants per hill at 3 ft. × 3 ft. spacing.

(*a*) On a poor sandy loam at Kasungu, with low total nitrogen (.042 per cent.) and organic carbon (.51 per cent.), there was a very large response to nitrogen applied at 0, 100 and 200 lb. per acre sulphate of ammonia, but no significant difference between yields at the different population levels obtained by growing 1, 2 or 3 plants per hill on a 3 ft.×3 ft. spacing.

TABLE XIV

Effect of Nitrogen and Plant Population on Maize Yields on Kasungu sandy soil

Variety: Local Yields: lb. grain per acre

Spacing	lb. of S/A. 0	100	200	Mean	Plants/ acre	Barren Plants	lb./ Cob
3′×3′×3 plants ..	636	1,357	2,199	1,398	13,470	4,080	.191
3′×3′×2 ,, ..	834	1,541	2,268	1,548	9,460	2,010	.273***
3′×3′×1 ,, ..	865	1,570	1,893	1,443	4,730	Nil	.393***
Mean N.	778	1,489***	2,120***			*Yield*	*lb./Cob*
Plants per acre ..	8,940	9,210	9,500	L.S.D. 5%			
Barren plants ..	3,540	1,750	630	Marginal Means		= 133	.022
lb. per Cob	.207	.300***	.351***	Centre Table		= 230	—
				Coef. Varn.		= 6.8%	5.7%

The higher the population, the greater the number of barren plants and the smaller the individual cob size. The significant interaction showed that whereas on unfertilized soil, three plants per hill gave poorer yields than the lower populations,

the difference was progressively eliminated and then reversed as the level of applied nitrogen was raised. On this rather infertile soil and with fertilizer application not exceeding 200 lb. sulphate of ammonia per acre the optimum plant spacing is 3 ft. × 3 ft. with two plants per hole.

(*b*) On an acid (pH 5.6) sandy clay loam at Namizana with a low nitrogen content (.097 per cent.) there were no significant differences in yield shown either by nitrogen application or by population (mean yield 1,315 lb. grain per acre; Coef. Varn.=7.1 per cent.) As in the Kasungu experiment the lower populations gave very much better cobs, and it is likely that here too, the recommended spacing under present fertilizer regimes, should be 3 ft. × 3 ft. × 2 plants.

(*c*) A maize Fertilizer and Spacing Trial was laid out on alluvial soil at Makanga, with a single replicate of a 3×3×3 design. Treatments were: nitrogen at nil, 200 lb. per acre S/A. at thinning time (December) and 200 lb. at tasselling (January); potash at nil, 100 lb. per acre sulphate of potash applied before planting and applied as burned cotton stalks in July, 1958; and spacing of 6 inches, 9 inches and 12 inches in the row with 3 feet between rows and one plant per hill. There were no responses to either the nitrogen or potash treatments, but there was a significant increase in yield when the intra-row spacing was reduced from 12 inches to 9 inches (6 inches spacing= 3590 lb.; 9 inches spacing=3550 lb.; 12 inches spacing=3300 lb. L.S.D. 5 per cent.=238; Coeff. Varn.=7.0 per cent.) There were no significant interactions.

3. WEED CONTROL

(*a*) *Hand Hoeing.* This experiment conducted at Chitedze on a red sandy clay loam of rather depleted fertility, was designed to find out the optimum for the first weeding of the maize crop, and the effect of weed growth later in the life of the plant. Weeds were nearly all grasses with a leavening of *Bidens* species, and other dicotyledonous plants. The design was a 4×2 factorial with four replications. The treatments were—first weeding 2, 3, 4 and 5 weeks after the first rains (the maize was dry planted) and clean cultivation versus weeding only when the weeds started to to flower.

TABLE XV

Effect of Different Weeding Treatments on Maize Yields

Variety: Namalenga *Yields: lb. per acre grain*

Treatment	*Yield*	*Treatment*	*Yield*
Weed at two weeks	1,791***	Clean weed after first weeding	1,881***
Weed at three ,, ...	1,751***	Weed only when weeds start to	
Weed at four ,, ...	1,495*	flower	1,131
Weed at five ,, ...	988		
L.S.D. 5%	459	L.S.D. 5%	324
Mean	1,506	Coef. Varn. ..	29.3%

The first weeding should be done not later than four weeks after planting (or after the first rains if dry planted). Also, later weed growth must be checked before it is big enough to start flowering in poor crops of maize, i.e., the crop should be weeded again in January before being finally banked up. In a vigorous, high yielding crop this later weed competition is not likely to be so serious from observations made on other fields, but the importance of early weeding stands. Thus another experiment at Chitedze containing early and late weeding gave the following results:

First weeding —31st December .. 3,267*
,, ,, —14th January .. 2,836
(L.S.D. 5%=437 Coef. Varn. =10.8%)

(*b*) *Chemical Control.* An observation on pre- and post-emergence spraying with 2–4D, M.C.P.A., and Simazin showed that a very effective kill of weeds can be obtained by a pre-emergence spray of 1–2 lb. a.i. of 2–4D or M.C.P.A., in about 100 gallons of water per acre. The maize was planted the day after the first good planting rains, no weeds having germinated, and the spray was applied the next day. The spray had little effect when applied post-emergence to grass about 1 inch high, though nearly all dicotyledons were killed. Simazin was not effective under these conditions. Plots sprayed with 2 lb. a.i. per acre 2–4D remained weed free right up to harvest, but in normal farming practice one cultivation at least, would have to be given to break up the surface crust on the soil. Yields of maize were not taken as the site had been differentially manured the previous season, but the sprays did not appear to injure the young plants.

4. CULTIVATION TRIALS

(*a*) *Time and method of hand-cultivation.* This trial was repeated at Chitedze on a red brown sandy clay loam where a maize crop followed tobacco fertilized with 200 lb. " C " mixture and 100 lb. sulphate of ammonia. The design was a 3×3 factorial with four replications. The treatments and their corresponding yields, were:

D_0	Make up old ridges ..	4,394	T_0	After Harvest July ..	5,031
D_1	Split ridges	5,003**	T_1	October	4,801
D_2	Dig up furrow then split ridges	5,450***	T_2	After 1st rains November ..	5,015
	L.S.D. 5% .. 436			Coef. Variation 10.5%	

This year there was a marked increase resulting from splitting the ridges, which confirms previous results, and also an increase as a result of digging in the furrows before splitting, which did not occur previously. As expected there was no significant difference between times of cultivation.

(*b*) The October Preparation of Gardens experiments at Chitedze and Tuchila showed increased effects from the treatments, the trends being the same as in previous years. In continuous maize cultivation it pays to split the ridges rather than remake them, and it pays to bury or burn stover rather than leave it as a mulch or cart it away, unless the carted stover is converted into manure and returned to the field as such.

(*c*) An observation at Chitedze on splitting tobacco ridges for maize as opposed to planting the maize on the old ridges without any further cultivation after tobacco uprooting, showed no significant difference between the treatments. This is in contradiction to the result obtained in (*a*) above, and will be further investigated.

OTHER CEREALS

Sorghums

No further experimental work was done.

Bulrush Millet

On alluvial soil at Makanga a composite crop obtained from a number of varieties imported from Nigeria produced 1,150 lb. per acre grain as compared with 470 lb. per acre from the Local Selection. This crop was planted on the first rain on 22nd December. A second crop planted a month later was so severely damaged by birds that it was not worth harvesting.

Finger Millet

(*a*) Duplicate plots on alluvial soil at Baka, Karonga, showed very little difference between broadcasting the seed at 5 lb. per acre (2,370 lb. grain per acre) and drilling the seed in rows one foot apart at 5 lb. per acre (2,130 lb. grain per acre).

(*b*) At Mbawa finger millet was planted early (3rd January, 1959) and late (24th January, 1959) on normal 3 feet ridges and on broad, flat 6 feet ridges. 100 lb. per acre sulphate of ammonia was applied about three weeks after planting. Yields in lb. per acre unthreshed heads were:

Early planted	3/1/59	1,310	..	3 feet ridges	799
Late ,,	24/1/59	886	..	6 feet ,,	1,397

(*c*) A series of district experiments was conducted in the Northern Province to test the effect of applying 200 lb. per acre sulphate of ammonia to finger millet planted early (mid-December) and late (mid-January). The design was a 2×2 factorial arranged as a Latin square. One experiment at Bulala also included a phosphate treatment, nil versus 200 lb. superphosphate, and the design here was a $2\times2\times2$ factorial in randomized blocks with three replications. At this site the early planting lodged, and had to be abandoned.

TABLE I

Effect of Fertilizer and Time of Planting on Finger Millet Yields

Variety: Local *Yield: lb. per acre agrain*

Site	*Bulala (Mzuzu)*	*Lazaro Jere (Mzuzu)*	*Baka (Karonga)*
Soil Type	Sand	Sandy Clay Loam	Sandy Loam
pH.	6.25	6.05	6.30
Total N. %	.040	.117	.096
Available P. p.p.m.	43	125	102
Early planted (Dec.)	Not harvested	1,726	2,202
Late planted (Jan.)	1,241	1,726	1,874
Nil	749	1,161	1,839
200 lb. per acre S/A	1,734***	2,290***	2,237
Nil	1,214	—	—
200 lb. per acre Supers ..	1,268	—	—
L.S.D. 5%	269	239	516
Mean	1,241	1,726	2,038
Coef. Varn.	15.4%	11.3%	22.4%

Time of planting between mid-December and mid-January does not appear to be critical, but crops planted too early may grow too rank and lodge. In upland areas there is a large response to sulphate of ammonia, but on Lake-shore alluvium there is none. This behaviour is the same as that previously shown for maize in fertilizer trials in the two areas.

Rice

Trial plots in Karonga District showed little response to 200 lb. per acre sulphate of ammonia when yields were about 1,300 lb. per acre paddy. They showed also that the yield of rice is very sensitive to the competition of grass weeds, and that any cultivation that decreases the weed population is likely to increase yields. The experiments were not very accurate as there is no control of flood water, and some damage was done during the Emergency.

OIL SEEDS

Groundnut Variety Trials

1. GROUNDNUT VARIETY TRIAL

A variety trial of eight varieties in a randomized block experiment with six replications was put down at five experimental stations to retest the latest choices, A.M. 2, Early Runner and Dixie Runner, against the standard varieties, for yield, oil content and disease resistance. Seven of the eight varieties were the same for all stations; the eighth varied according to stations.

TABLE I

Results of Groundnut Variety Trial

Variety: See below *Yields: lb. per acre shelled nuts*

Station		*Chitedze*	*Chitala*	*Tuchila*	*Makanga*	*Mbawa*
Soil Type		S.C.L.	S.L.	S.C.	*Alluvium*	S.C.L.
Variety	*Type*					
A.R.A. Spanish	B.E.	1,578	1,204	937	1,270	1,043
Gambia	B.E.	1,694	1,786	686	1,749	1,312
Mwitunde	B.L.	1,796	1,358	158	744	1,184
Early Runner	R.M.	1,954	1,727	418	1,133	1,475
A.M.2	R.M.	1,565	1,600	493	990	1,479
Dixie Runner	R.L.	1,725	1,527	284	1,123	2,010
Chalimbana	R.L.	1,556	928	436	758	1,778
Mani Pintar	B.L.	2,385	1,397	—	—	—
U/A 15	B.E.	—	—	103	296	—
Kongwa Red	R.L.	—	—	—	—	1,316
L.S.D. 5%		267	154	222	55	238
Mean		1,782	1,411	439	1,008	1,450
Coef. Varn.		18.5%	9.2%	43.3%	14.0%	14.0%

Tuchila suffered a severe outbreak of "rosette" virus disease which appeared first in the variety U/A 15 (two year old seed) producing rather a poor stand, and rapidly spreading to other varieties. The same pattern appears this year as in the past. Oil contents are given below:

TABLE II

Oil Content of Groundnut Varieties at Different Stations

Variety: See below *Oil as per cent. dry kernel*

Variety	*Chitedze*	*Chitala*	*Tuchila*	*Makanga*	*Mbawa*	*Mean*
A.R.S. Spanish	48.7	51.2	53.8	50.1	50.9	50.9
Gambia	47.4	52.8	51.4	50.6	49.7	50.4
Mwitunde	48.4	53.5	49.8	50.9	52.3	51.0
Early Runner	47.6	51.6	48.6	51.8	46.5	49.2
A.M.2	45.6	51.3	49.4	52.8	48.4	49.5
Dixie Runner	48.3	52.4	50.2	52.6	50.5	50.8
Chalimbana	43.4	47.6	45.5	48.1	45.5	46.0
Mean for Station	47.1	51.5	49.8	51.0	49.1	49.7
Altitude—Ft. A.S.L.	3,600	2,000	2,500	120	4,000	
Approx. Rainfall (inches)	36.07	34.55	34.30	29.12	32.98	

TABLE II—*(Continued)*

Variety	*Chitedze*	*Chitala*	*Tuchila*	*Makanga*	*Mbawa*
Mani Pintar	48.8	54.5	—	—	—
U/A 15	—	—	51.6	52.4	—
Kongwa Red	—	—	—	—	49.7
S. Rhodesian I	50.1	—	—	—	—
,, II	48.4	—	—	—	—
,, III	48.7	—	—	—	—
,, IV	49.2	—	—	—	—

Should the policy be to produce a uniform pink-skinned, medium-sized nut over the whole territory, Mwitunde, Early Runner and Dixie Runner would appear to make up a suitable group, Mwitunde and Dixie Runner doing for the plateau areas of Central and Northern Provinces and Early Runner for the Lake-shore and Southern Province. A.M. 2 suffers a high proportion of shrivelled nuts and may be dropped in favour of Early Runner. If colour of seed coat is not important, Mani Pintar is well worth further trial, having very nicely filled nuts, a high yield and a high oil content. The large Chalimbana type nut, if required for the confectionery trade in spite of its low oil content, should be encouraged only in the Mzimba area where it has repeatedly yielded with the best. In other parts its yield is not spectacular. The differences in mean oil content between stations should be noted, the low altitude stations having a higher oil percentage. Note also that the selections from a Southern Rhodesian sample grown at Chitedze had a higher oil content than the locally adapted varieties.

2. EXTRACT FROM REPORT OF THE AGRICULTURAL CHEMIST, BVUMBWE

Confectionery Trade

In connection with this possible field for development, the acidity of the oil in a range of samples was found to be 0.3 per cent–0.8 per cent. with an average of 0.5 per cent.

3. DISTRICT VARIETY TRIALS

(*a*) A number of simple randomized block variety trials were conducted in farmers' gardens in the Northern Province, to find out how far the finding that long term varieties were best for the plateau areas, and short term ones for the Lake-shore, applied. Results shown below confirmed this finding.

TABLE III

Results of District Variety Trials in Northern Province

Variety: see below *Yields: lb. per acre shelled nuts*

Station		*Katowo Ru*	*Ng'onga Ru*	*Luwiri Ru*	*Mavadadi Mzuzu*	*Bulala Mzuzu*	*Njinji Mzuzu*	*Baka* Ka*
Variety	*Type*							
A.R.S. Spanish ..	B.E.	973	500	1,004	911	401	578	1,380
Early Runner ..	M.R.	1,094	1,004	1,237	959	623	904	—
Mwitunde	L.B.	1,152	1,166	1,540	1,437	1,067	1,311	1,117
Chalimbana	L.R.	965	723	—	1,095	1,011	1,289	968
Local	L.R.	1,070	—	1,319	1,302	709	1,291	877
L.S.D. 5 per cent ..		256	232	460	203	58	155	221
Coeff. Varn.		17.6%	22.3%	20.8%	10.5%	4.5%	10.5%	13.3%

N.B.: Baka lies in the Lake-shore—all other sites are on the plateau areas.

(*b*) A number of variety observations were also carried out in the Dedza Highlands of Central Province (N.A.K-Gwaza). Yields at all three sites were miserably low—200 to 500 lb. per acre shelled nuts. The best of the introduced varieties tried appear to be Dixie Runner and Early Runner, though the A.R.S. Spanish also did relatively well at two sites. Twenty-four gardens in this area east of Dedza Mountain, when sampled, gave yields ranging from 40–300 lb. per acre. Samples from N.A. Kasumbu, north-west of Dedza Mountain, ranged from 140–640 lb. per acre. Other parts of Dedza average a more normal yield of 600–700 lb. per acre. On Dedza Lake-shore two samples of the early variety Gambia averaged 700 lb. per acre, while 13 samples of local runner averaged but 360 lb. per acre.

Groundnut Fertilizer Trials

1. FERTILIZER TRIALS—CENTRAL PROVINCE

The object of this experiment was to see whether groundnuts would respond to fertilizer on the red-brown sandy clay loam of Chitedze and the brown sandy clay loam of Chitala. On both soils total nitrogen percentage was high, as was the potash content. Available phosphate was low. The design was a 3×2 factorial with three replications and the treatments 0, 100 lb. per acre gypsum, and 200 lb. per acre superphosphate, in combination with 0 and 50 lb. per acre muriate of potash. All fertilizers were applied before planting in a band in the ridge. Coefficients of variations were low and mean yields high (Chitedze 1,820 lb. per acre, Coef. Varn.=6.5 per cent., and Chitala 1,610 lb. per acre, Coef. Varn.=6.4 per cent.), and there were no responses to any of the fertilizers applied.

2. FERTILIZER TRIALS—NORTHERN PROVINCE

These trials were conducted on soils known to be responsive to fertilizers, chiefly those containing sulphur and phosphate, in order to find out which elements were limiting yields, and which fertilizers were best applied as a remedy.

(*a*) At Mbawa on a sandy clay loam low in nitrogen, but with reasonable P. and K. levels, the experiment was a 2×5 factorial with four replications. The treatments were nil and 200 lb. per acre superphosphate (S.+P.) in combination with nil, 200 lb., per acre sulphate of ammonia (S.+N.) 100 lb. per acre urea (N. only), 300 lb. per acre gypsum (S.+Ca.) and both urea and gypsum at the above levels (N.+S+Ca). There was a very marked interaction.

TABLE IV

Effect of Superphosphate, Sulphate of Ammonia, Urea and Gypsum on Groundnut Yields

Variety: Mwitunde *Yields: lb. per acre shelled nuts.*

	Nil	200 *lb. per acre Supers*	*Difference Due to*
Nil	1,452	2,068 (P,S,Ca)	+616 (P,S,Ca)
200 lb. S/A	1,630 (S, +N)	1,801 (P,S,Ca,N)	+171 (P, +Ca)
100 lb. Urea	1,543 (N)	1,804 (P,S,Ca,N)	+261 (P,S,Ca)
300 lb. Gypsum	1,785 (S, +Ca)	1,708 (P,S,Ca)	— 77 (P only)
Urea and Gypsum	1,911(S, +Ca, +N)	1,925 (P,S,Ca, N)	+ 14 (P only)

Coef. Varn.=10.5% L.S.D. 5%=266

From examination of the table, it is apparent that though there was a significant overall response to single superphosphate, it was not the phosphate it contained that gave the increase, but the sulphur and possibly the calcium in combination with it. Superphosphate gave the greatest increase in yield when applied alone followed by gypsum a rather poor second. The major deficiency is evidently sulphur (with

calcium) and where this is applied either as gypsum, where phosphate is not low, or as single superphosphate on phosphate deficient soils, no other fertilizers will give increases. In the absence of either of these fertilizers all sorts of unexpected responses are obtained, due possibly to sulphur impurities in the chemicals used (see below).

(*b*) On farmers' gardens at Njinji and Bulala, further fertilizer trials were laid out to test the effects of 100 lb. nitrate of soda, 100 lb. gypsum, 200 lb. of triple superphosphate and 5 tons per acre farmyard manure. Both soils were loamy sands with low nitrogen content and adequate potash. Phosphate level was high at Njinji and low at Bulala. The design at Njinji was a $2\times2\times2\times2$ factorial with the third order interaction confounded and two replications. At Bulala, the treatments were applied as a simple randomized block experiment with three replications of six treatments. Again there were marked interactions.

TABLE V

Effect of Gypsum, Triple Supers, Nitrate of Soda and F.Y.M. on Groundnuts

Variety: Local Yield: lb. per acre shelled nuts

Sites	*Njinji*			*Bulala*	
Treatment	*Nil*	*100 lb. Gypsum*	*Difference*	*Treatment*	*Yield*
Nil	1,073	1,875	+802***	Nil	554
100 lb. $NaNO_3$ ..	1,308	1,934	+626***	100 lb. Gypsum ..	856*
				100 lb. $NaNO_3$ ..	576
Difference	+235**	+59	1,492	200 lb. Triple Supers ..	721
Nil	984	1,909	+925***	Gypsum, +$NaNO_3$ Triple	880*
200 lb. Triple Superphosphate ..	1,397	1,900	+503***	5 tons F.Y.M. ..	626
Difference	+413***	—9	1,492		
L.S.D. marginal means 112 lb. p.a.					
Nil	1,449				
5 tons F.Y.M.	1,535				
Difference	+86**				
Coef. Varn.=7%	L.S.D. 5% ..		79	Coef. Varn.	18.1%
				L.S.D. 5% ..	230

In the presence of gypsum, neither nitrogen nor phosphate has any effect, but in the absence of gypsum both appeared to increase yields. The response to F.Y.M. was not large enough to make up for the difficulty of obtaining and applying it.

Though without doubt very beneficial results will be obtained at the present by applying gypsum to the groundnut crop on certain soil types in the Northern Province, it may well be that in the long run, the sulphur content of the soil can be maintained at an adequate level by applying sulphate of ammonia to the maize crops and single superphosphate to either the maize or the groundnuts.

3. FERTILIZER TRIALS—SOUTHERN PROVINCE

In one trial on alluvial soil at Makanga, an application of 10 tons of khola manure had no effect on a control yield of 780 lb. per acre shelled nuts, while a 20 ton dressing significantly reduced yields. (Coef. Varn.=17.0 per cent.)

4. RESIDUAL FERTILIZER TRIALS

Groundnuts grown on the sites of previous maize fertilizer trials at Chitedze in the Central Province and at Ng'onga and Katowo in Rumpi District of the Northern Province, showed no residual effects from up to 300 lb. per acre sulphate of ammonia or 200 lb. per acre single superphosphate applied in the previous season.

5. EXTRACT FROM REPORT OF THE AGRICULTURAL CHEMIST, CHITEDZE

" Pops " in Groundnuts

The experimental programme designed to investigate this problem more comprehensively was unfortunately postponed, and only one sample of affected and healthy plants from the same area was examined.

The samples were divided into haulms, pods and kernels and analysed separately. The higher K/Ca ratios in the affected plants noted last season have again been demonstrated, particularly in the pods and kernels (*see* Table VI below). Of interest also are the considerably higher levels of nitrogen and phosphate in the affected plants which may be due to incomplete utilization of food reserves brought about by the K/Ca imbalance.

Detailed investigational experiments on this subject are to be carried out in the Northern Province during the coming season.

TABLE VI

Analysis of Groundnut " Pop " Material

Lab. No.		*Per cent. N*	*Per cent. P*	*Per cent. K*	*Per cent. Ca*	*K/Ca ratio*
	Affected					
839*a*	Haulms	2.38	.13	2.11	.69	3.1
b	Pods	2.12	.13	2.11	.26	8.1
c	Kernels	5.01	.44	1.09	.08	13.6
	Healthy					
840*a*	Haulms	1.09	.05	2.74	.97	2.8
b	Pods	1.01	.03	1.34	.26	5.3
c	Kernels	4.64	.39	0.82	.14	5.9

Groundnut Cultivation Trials

1. RIDGING AND MULCHING TRIAL

This trial at Makanga on alluvial soil is intended to test the effect of water conserving measures on the crops in the rotation at the station. The design is a 3×3 factorial with six replications and the treatments are, flat cultivation, ridge cultivation and box ridge cultivation in combination with no mulch, light mulch and heavy mulch. Yields were not very heavy (493 lb. per acre shelled nuts) and the coefficient of variation rather large (22.0 per cent.). Box ridging gave significantly better yields than either flat or ridge cultivation, and mulch of any thickness was very much better than no mulch. As each moisture conservation measure is only really effective in the absence of the other, the practical application would be to apply mulch to any land cultivated on the flat, and to box ridge any land for which there is no mulch.

2. TIME OF PLANTING AND LIFTING

This trial at Makanga was to determine the best time of planting groundnuts in the Lower River and to find out how long it takes for the nuts to mature to maximum yield. The design was a 2×2 factorial with plots split into five sub-plots. Main treatments were two varieties, the short term A.R.S. Spanish, and the long term Mwitunde, in combination with early and late planting, 22/12/58 and 20/1/59 respectively. The sub-plots were lifted at 10 day intervals from 90–130 days inclusive, for the early variety and 110–150 days for the late one.

TABLE VII

Effect of time of Planting and time of lifting on two Varieties of Groundnuts

Varieties: A.R.S. Spanish, Mwitunde Yields: lb. acre shelled nuts

	Planted	
A.R.S. Spanish	*22nd December*	*29th January*
Lifted		
90 days..	744	459
100 ,, ...	1,144	499
110 ,, ...	1,051	408
120 ,, ...	1,269	348
130 ,, ...	885	471
Mean	1,014	435
Mwitunde		
Lifted		
110 days..	278	230
120 ,, ...	482	263
130 ,, ...	762	273
140 ,, ...	698	291
150 ,, ...	663	238
Mean	566	260

Coef. Var. = 14%. L.S.D. 5% = 96 per acre

The A.R.S. Spanish gave the best yield when lifted at 110–120 days if planted in December, but it made little difference when the January planted crop was lifted as the rains finish before it can fully mature and sprout. The December planted Mwitunde yielded best when lifted at 130 days, while the late planted crop gave a miserable yield however long it was left in the ground.

3. WEED CONTROL IN GROUNDNUTS

(*a*) Hand hoeing. On red-brown sandy clay loam at Chitedze weeding trials were conducted with three different varieties to determine the optimum time for the first weeding and the optimum number of weedings for the groundnut crop. The design was a randomized block experiment with four replications planted to each variety, and the plots split for one row per ridge versus two rows per ridge planting. Varieties were A.R.S. Spanish (early bunch type spaced at 9 inches in the row), Mwitunde (late bunch type spaced at 9 inches in the row), and Dixie Runner (late runner type spaced 12 inches in the row). The treatments are shown below with the number of weeks from planting that each weeding occurred—these are different for the early variety and for the late varieties (E 2+6; L 2+7).

TABLE VIII

Effect of Various Weeding and Spacing Treatments on Groundnut Yields

Variety: see below *Yields: lb. per acre shelled nuts*

Treatment (E2+6; L2+7)	*A.R.S. Spanish (Early bunch)*	*Mwitunde (Late bunch)*	*Dixie Runner (Late Runner)*
Early weeding +1 other (E2+6;L2+7)	1,231**	1,837	1,680
,, ,, +2 others (E2+6+10;L2+7+13) ..	1,237**	1,795	1,804*
,, ,, +3 others (E2+4+6+10) (L2+4+7+13)	1,181*	1,922*	2,037*
Weeding delayed +1 (E4+8; L4+10)	991	1,739	1,550
,, ,, +2 (E4+6+10;) (L4+7+13) ..	1,095*	1,859	1,732*
,, late +1 (E6+8; L7+10)	888	1,656	1,365
L.S.D. 5%	173	195	329
1 Row per ridge	997	1,843*	1,722
2 Rows ,, ,, ...	1,209***	1,762	1,670
L.S.D. 5%	77	81	80
Mean	1,104	1,801	1,695
Coefficient of Variation	11.5%	7.4%	7.7%

In these experiments the weeds hardly ever overtopped the groundnuts which grew vigorously. Differences between treatments have thus not been marked. Earliness of the first weeding is more important if the variety is a small upright one like A.R.S. Spanish than it is for the larger runners and late bunch varieties. It should not however be delayed much more than four weeks from planting. The short term varieties appear to need at most three weedings under average conditions, while one can probably get away with an early weeding and one more, if these are well spaced and carried out. The long term varieties need more weeding, an early weeding, a later one and one hand pulling of weeds.

Though two rows per ridge gave a greater yield of the early bunch variety than one row per ridge, the position was, if anything, reversed with the larger topped varieties. This needs confirmation as it is contrary to previous experience. Perhaps the controlling factor is density of canopy rather than plant population itself.

Sesame

The ratoon crop from the plots of indigenous sesame (*S. angolense*) was harvested at Chitedze and Tuchila. There were indications that the plots planted late in the 1957/58 season (January) gave higher yields in the second season, but the difference was more than compensated by the higher yields obtained in the first season from the early (December) planted plots.

Mean yields were:

Chitedze ..	1st year	65 lb. per acre seed	
	2nd ,,	260 ,, ,, ,, ,,	
Tuchila ..	1st ,,	130 ,, ,, ,, ,,	
	2nd ,,	350 ,, ,, ,, ,,	

Three imported varieties of *S. indicum* which showed promise last year were planted again at Chitala at the end of December. The crop was sown too thickly and part of each plot was thinned at the end of January. The crop did not grow well and thinning made no difference. The best yield obtained was but 90 lb. per acre seed.

Linseed

A variety trial was planted under irrigation in the winter months at Makanga. The design was a randomized block experiment with five replications.

TABLE IX

Yields of Linseed under Irrigation

Variety: see below *Yield: lb. per acre seed*

Variety	*Yield*
Mwera Hill	979
Makwapala	976
Tung Station	891
Punjab	767
S. African	737
L.S.D. 5%	146
Mean	870
Coef. Varn.	13.0%

OTHER LEGUMES

Groundbeans (*Voandzeia subterranea*)

At Chitedze very good yields were obtained from groundbeans planted on 11th December, which were able to grow for 146 days before lifting. This was the variety trial, a randomized block experiment with five replications and eight varieties as shown below.

Other plots in the same field for bulking up seed were planted on 24th January, and were ready for lifting after 118 days. These plots gave less than one-fifth of the yield of the variety trial. Up to 65 per cent. of the beans became detached from the plants on lifting and remained on or in the ground. Gleaning is thus very important in this crop if maximum yield is to be obtained.

TABLE I

Yield of Groundbean Varieties at Chitedze

Variety: See below *Yield: lb. per acre shelled seed*

Variety	*Seed Colour*	*Early Planted Trial*	*Late Planted Trial*
Barotseland	Cream	3,373	318
Northern Rhodesia	Pale Brown	3,185	377
Mbawa B.	Dark Purple	2,676	269
Mbawa D.	Pale Brown	2,207	431
Mbawa C.	Red	2,173	311
Mbawa A.	Cream, Black Eye	2,086	480
Tuchila B.	Brown	2,057	363
Tuchila A.	Pale Brown	1,747	313
L.S.D. 5%		623	—
Mean		2,438	—
Coef. Varn.		19.8%	—

If such yields can be obtained next year, the crop may be well worth pushing as it is greatly relished for food. Shelling the seed is a tiresome business as the shells fit the seeds very closely.

Canadian Wonder Beans

1. TIME OF PLANTING TRIAL

On red-brown sandy clay loam at Chitedze, a randomized block experiment with split plots and three replications, was laid out to find out the optimum time of planting of Canadian Wonder beans on second-year arable land after maize. There were four planting dates and the plots were split for presence and absence of 200 lb. per acre superphosphate.

TABLE II

Effect of Time of Planting on Bean Yields

Variety: Canadian Wonder Small *Yields: lb. per acre seed*

Time of Planting	*Yield*	*Phosphate Level*	*Yield*
End of January	1,443	No phosphate	536
Early February	658	200 lb. acre Supers	576**
End of February	96	L.S.D. 5%	18
Early March	28		
L.S.D.	77	Coef. Varn.	5.1%

The last two plantings just did not grow, due probably to drought, and stem fly and *Mylabris* beetle both contributed to the lowering of the yields of the later planted crops.

The responses to phosphate were not economic.

Beans ought to be planted before the end of January.

2. OBSERVATIONS ON CATCH CROPPING WITH BEANS

On brown sandy clay loam at Chitedze, Canadian Wonder beans were planted as a catch crop in mid-February on land newly ploughed up from Rhodes grass pasture. 100 lb. per acre sulphate of ammonia was applied before ploughing to half of the twelve plots. Yields were poor and there was a visible response to the nitrogen:

No Nitrogen—217 lb./acre seed, 100 lb./acre S/A—278 lb./acre seed.
L.S.D. 5%=46 Coef. Varn.=12.1%

Cowpeas

The variety Mwazisi planted at Chitedze in mid-February as a catch crop on land newly ploughed out of Rhodes grass ley did not suffer from *Ascochyta* leaf spot, and yielded about 500 lb. per acre seed in spite of stunted growth. There was no response to superphosphate applied under the ridge before planting.

Soya Beans

1. Three tall, late-growing varieties suitable for green manuring, gave only 200 lb. per acre seed when planted in mid-January. These varieties Hernon 237, Benares and Malaya, must be planted in early December if seed is to be harvested.

2. An area of Pelican soya beans drilled on the flat at Chitedze in rows two feet apart and mechanically cultivated until too large to take the tractor, yielded about 600 lb. per acre seed. The crop had to be hand hoed once, and harvested by hand in the absence of suitable machinery.

3. Soya varieties planted in observation plots in the Dedza Highlands, yielded as poorly as groundnuts do in that area, except at one site. The best variety, Pelican, yielded 600 lb. per acre seed at Mwalawankhondo, 480 lb. seed at Bembeke and 180 lb. seed at Magunditsa.

4. VARIETY OBSERVATIONS AT BVUMBWE

It is the object of the Bvumbwe Mixed Farm Unit to obtain ten (× 200 lb.) bags of soya grain per acre. After three years trial Volstate and Pelican were the varieties which most nearly attained that yield. Small quantities of seed of varieties new to Nyasaland were imported in 1958 with the object of observing if they were in any way superior to those already selected. Of them Masterpiece, Gunson's Browny and 54S181 proved to be dwarf, precocious and low yielders, suited to higher latitudes than Bvumbwe. Those selected for further trial are Hernon 107 and Hernon 147 from Rhodesia and 51S137 and 54S70 from the Transvaal.

ROOT CROPS

Sweet Potatoes

At Chitedze a fertilizer trial was laid down on land newly opened from Rhodes grass ley. The sweet potatoes were thus grown as a catch crop planted on 17th February and harvested on 21st August. The design was a $4\times2\times2$ factorial with second order interaction confounded, having three replications in six blocks. Treatments included four varieties, sulphate of ammonia at nil and 200 lb. per acre and superphosphate at nil and 200 lb. per acre. There were no responses to either fertilizer, and yields were low due to late planting as may be seen from the yields of the varieties given below in short tons per acre. Mkokabwato 2.57, Malamulo 1.85, Kamciputu 1.32 and Kacamba 1.30 (L.S.D. 5%=32, Coef. Varn.=22.0%).

For reasonable yield sweet potatoes should be planted before the end of January.

Irish Potatoes

A number of variety and fertilizer trials were carried out in the Dedza Highlands on red sandy clay soils with a low pH (5.75 and 5.85) but with high total nitrogen and available phosphate analyses. Potash was in one case adequate and in the other low. All experiments were badly hit by late blight (*Phythophthora infestans*) which reduced yields to the order of one short ton per acre, and made coefficients of variation very high. There was a significant increase of .73 short tons per acre at one site in response to 200 lb. per acre sulphate of ammonia, and one of .76 short tons per acre at the other site in response to F.Y.M. There were no responses to phosphate, potash or ash.

There was definite evidence in favour of planting seed stored and sprouted in Dedza rather than unsprouted seed " grown on " outside the district at Nchenachena or Makanga.

Potatoes planted at 12 inches in the row yielded nearly half as much again a potatoes planted at 24 inches in the row.

All these experiments need to be repeated for confirmation.

Cassava

The second lifting of the variety trial at Kota Kota was completed this year, giving yields rather larger than those obtained in the first lifting, but with the varieties in much the same order. The experimental design gave six replications of a pair of main plots planted early and late respectively; each main plot contained the eight varieties in sub-plots. Three replications were lifted at ten to twelve month's old and the other three at sixteen to eighteen month's old. The soil is recent alluvium liable to flooding.

TABLE I

Yield of Cassava Varieties at Kota Kota

Varieties: see below *Yield: short tons per acre roots*

Variety	Type	1st lifting December 1959	2nd lifting July 1959	Mean
Bitisumani	Sweet	3.62	5.84 } *	4.73
T_{11}	Bitter	3.04	5.44 }	4.24
Somaliland	Sweet	3.00	4.52	3.76
Kawalika	Bitter	3.21	4.25	3.73
Thipula	Bitter	3.92	4.13	4.02
T_{19}	Bitter	4.00	3.94	3.97
T_{14}	Sweet	2.71	3.68	3.19
T_{18}	Sweet	1.67	2.68	2.17
L.S.D. 5%		1.37	1.85	
Early planted December, 1957		3.68	4.33	4.00
Late planted March, 1958		2.61	4.28	3.44
Mean		3.14	4.30	3.72
Coef. Varn.		36.8%	38.0%	

In spite of their somewhat greater " mosaic " resistance, the Amani varieties do not yield any better than the local ones, and most of them are less palatable. An outstanding exception of this is T_{18} which is very palatable, but yields very badly.

TOBACCO

Dark Tobacco

Except where otherwise stated all experiments have been conducted at Chitedze Agricultural Research Station, on a red-brown sandy clay loam showing adequate amounts of nitrogen and potash, but a rather low phosphate status.

1. VARIETY AND FERTILIZER TRIAL

The trial was designed as a randomized block experiment, the main treatments being 200 lb. nitrogen per acre, and 200 lb. superphosphate per acre applied singly and in combination. The varieties were planted as sub-plots and as in last year's trial, the aim was to test out the same four imported varieties with a selection of the local " Western " strains.

TABLE IA

Dark Tobacco Variety Trial at Chitedze (sub-plots)

Variety	*Yield (lb./ acre)*	*Grade Index*	*Crop Index*
A.R.S. 53	1,224	32.21	39,419
Toleza 58	1,140	32.84	37,456
C3–42–AA	1,097	32.07	35,184
A.R.S. 51	1,070	32.79	35,075
Greenwood	1,069	30.42	32,531
Little Crittenden	1,037	30.90	32,053
CI–14–A	1,034	28.98	29,968
Type 5	1,032	27.91	28,811
Western: Lingadzi	1,028	26.79	27,547
A.R.S. 56	1,024	29.41	30,128
Western: Songea	1,003	26.30	26,370
Madole	990	25.02	24,776
Mean	1,062	29.64	—
L.S.D. (P=0.05)	147	3.72	—
Coeff. of Variation	17,0%	15.4%	—

The results show that A.R.S. 53 yielded significantly better than all varieties other than Toleza 58 and C3–42–AA. Apart from Madole which was significantly worse than Toleza 58 and A.R.S. 53, there was no difference between the other eleven varieties. Considering quality there was no significant difference between any one of the top six or any one of the bottom six varieties. Madole gave significantly lower quality leaf than any of the top seven varieties.

TABLE IB

Dark Tobacco Fertilizer Trial at Chitedze (main plots)

(a) Cured Leaf

Fertilizer	*Yield (lb./ acre)*	*Grade Index*	*Crop Index*	*Percentage Leaf Wrapper**
No Fertilizer	933	25.79	24,067	Nil
200 lb./acre Superphosphate	825	26.37	21,763	Nil
200 lb./acre Sulphate of ammonia	1,083	33.54	36,311	1.87
200 lb./acre Superphosphate + 200 lb./acre Sulphate of ammonia	1,409	32.84	42,267	0.90
Mean	1,062	29.64	—	—
L.S.D. (P=0.05)	157	8.51	—	—
Coefficient of Variation	25.6%	49.8%	—	—

*Not analysed statistically

(b) Green Leaf—Middle Leaf Left at Priming and Topping

Fertilizer	*Length (Inches)*	*Width (Inches)*	*Length Width Ratio*
No Fertilizer	27.00	10.57	2.588
200 lb./acre Superphosphate	26.14	10.40	2.531
200 lb./acre Sulphate of ammonia	27.85	11.26	2.503
200 lb./acre Superphosphate + 200 lb./acre Sulphate of ammonia	31.98	13.27	2.424
Mean	28.24	11.37	2.511
L.S.D. (P=0.05)	3.00	1.24	0.068
Coefficient of Variation	18.4%	18.9%	4.7%

Considering the fertilizer treatments it can be seen that there is a definite yield increase from applying sulphate of ammonia and superphosphate together, which is much greater than one would expect from a consideration of the yields when the fertilizers were applied alone. This interaction effect was also very marked in the same trial in 1957/58. The results also show a response to 200 lb. sulphate of ammonia which is approaching, but is not quite statistically significant. The sulphate of ammonia alone, and with superphosphate, improved quality, although not statistically and the very high coefficients of variation for this analysis must be noted.

The effects of the fertilizer treatments on green leaf measurements also correspond with the findings in 1957/58; the combination of 200 lb. per acre superphosphate and 200 lb. per acre sulphate of ammonia significantly increasing both leaf length and width. There is no doubt that the application of fertilizer helps to give leaves of a length and width desired by the trade. The effect on leaf quality this year, when the

general quality of tobacco has been low, is not clear, but the application of fertilizer is definitely one of the factors which improve quality. Others such as climate, topping and priming practices and curing, obviously also play a part.

2. CULTURAL TRIALS

Three 3×3 trials with identical treatments were carried out, two at Chitedze (C.P.) and one at Tuchila Experimental Station (S.P.). Planting at Chitedze was early (27th November) and late (13th January) and at Tuchila early (22nd November). The treatments were topping five leaves (one leaf below flag leaf), six leaves (two leaves below flag leaf) and seven leaves (three leaves below flag leaf). Priming was then carried out so that for each of these treatments in the early planted trials, nine, ten and eleven leaves per plant were left until harvest.

TABLE II

Topping and Priming Trial at Chitedze—planted 27th November

(Fertilizer—a basic dressing of 200 lb. sulphate of ammonia, and 200 lb. " C " mixture per acre)

(a) Cured Leaf

Treatment	*Yield (lb./ acre)*	*Grade Index*	*Crop Index*
(i) Topping			
Topping five leaves	1,001	43.87	43,290
,, six ,, ...	1,100	42.15	46,387
,, seven ,, ...	1,134	42.32	48,004
(ii) Priming			
Harvest nine leaves	959	45.10	43,265
,, ten ,, ...	1,096	41.83	45,846
,, eleven ,, ...	1,181	41.41	48,891
Mean	1,079	42.78	—
L.S.D. (P=0.05)	87	3.91	—
Coeff. of Varn.	9.5%	10.8%	—

(b) Green Leaf—Tenth Node

Treatment	*Length (Inches)*	*Width (Inches)*	*Length Width Ratio*
(i) Topping			
Topping five leaves	26.41	9.86	2.69
,, six ,, ...	26.38	9.87	2.69
,, seven ,, ...	25.56	9.66	2.70
(ii) Priming			
Harvest nine leaves	26.23	9.84	2.68
,, ten ,, ...	26.23	9.77	2.71
,, eleven ,, ...	25.92	9.68	2.69
Mean	26.12	9.78	2.69
L.S.D. (P=0.05)	0.64	0.22	0.39
Coefficient of Variation	2.9%	2.7%	1.7%

In the early planted trial at Chitedze, topping either six or seven leaves significantly increased yield, as did increasing the number of leaves left until harvest. Where more leaves were harvested the quality of leaf did fall, but not significantly.

The number of leaves harvested did not significantly affect leaf length or width, but topping seven instead of six or five leaves reduced both length and width. It can, therefore, be seen that in this trial topping had more effect on the crop than priming, and the best yield of tobacco with long, wide leaves was obtained by topping six leaves.

TABLE III

Topping and Priming Trial at Tuchila—planted 22nd November

(Fertilizer—a basic dressing of 200 lb. sulphate of ammonia and 200 lb. " C " mixture per acre)

Treatment	*Yield (lb./ acre)*	*Grade Index*	*Crop Index*
(i) Topping			
Topping five leaves	1,431	69.02	98,784
,, six ,,	1,468	66.32	97,385
,, seven ,,	1,498	68.25	102,228
(ii) Priming			
Harvest nine leaves	1,316	69.69	91,742
,, ten ,,	1,494	69.04	103,152
,, eleven ,,	1,587	64.86	102,932
Mean	1,466	67.86	—
L.S.D. (P=0.05)	88	3.03	—
Coeff. of Variation	8.9%	6.6%	—

At Tuchila the topping treatments did not significantly affect yield or quality. Yield was significantly increased as more leaves were left to mature, but leaving eleven rather than nine or ten leaves significantly reduced quality.

TABLE IV

Topping and Priming Trial at Chitedze—planted 13th January

(Fertilizer—a basic dressing of 200 lb. sulphate of ammonia and 200 lb. " C " mixture per acre)

Treatment	*Yield (lb./ acre)*	*Grade Index*	*Crop Index*
(i) Topping			
Topping five leaves	438	11.90	5,213
,, six ,,	521	12.52	6,525
,, seven ,,	627	12.96	8,132
Mean	529	12.46	—
L.S.D. (P=0.05)	63	1.34	—
Coeff. of Varn.	12.0%	10.8%	—

Unfortunately, all the treatments could not be applied to this experiment, and it was primed uniformly so that comparison is only possible between the various topping treatments. The yield and quality are very low and when compared with the previous tables, emphasize once again the value of early planting. The results show that low topping in a late planted crop will increase yield.

3. FERTILIZER TRIALS

(*a*) 25.10.0 *Mixture Trial at Chitedze*

In the belief that cropping with tobacco which has only received sulphate of ammonia, will eventually deplete soil reserves of phosphate, an attempt is being made to find a suitable fertilizer mixture which could be made generally available once it has been proved satisfactory. The mixture tried this year contained 25 per cent. nitrogen and 10 per cent. phosphate, and was compared in a randomized block experiment with equivalent amounts of sulphate of ammonia and superphosphate mixed together, and also with sulphate of ammonia alone.

TABLE V

Dark Tobacco 25.10.0 Fertilizer Trial

Total nutrient lb.		*Fertilizer*	*Yield (lb./ acre)*	*Grade Index*	*Crop Index*
N.	P_2O_5				
0	0	Nil	972	31.40	30,533
25	10	100 lb./acre 25.10.0 mixture	1,150	31.42	36,129
24	0	120 lb./acre Sulphate of ammonia	1,038	30.99	32,172
24	10	120 lb./acre Sulphate of ammonia + 50 lb./acre Superphosphate	1,204	33.74	40,614
50	20	200 lb./acre 25.10.0 mixture	1,174	27.96	32,816
48	0	240 lb./acre Sulphate of ammonia	1,174	34.55	40,558
48	20	240 lb./acre Sulphate of ammonia + 100 lb./acre Superphosphate	1,359	34.01	46,221
		Mean	1,153	32.01	—
		L.S.D. (P=0.05)	141	4.65	—
		Coefficient of Variation	10.4%	12.3%	—

The mixture at both levels of application gave a significant yield increase over no fertilizer, but there was no significant difference between applying 100 and 200 lb. of the mixture. Combined application of single superphosphate and sulphate of ammonia at both levels also significantly increased yields over no fertilizer, but in this case there was also a significant difference between the two levels. In addition, there was a significant difference between the higher level of the mixture and the higher level of single superphosphate, plus sulphate of ammonia, in favour of the latter. It appears, therefore, that, particularly at the higher levels of application, the mixture is less effective than the combined dressing of the separate nitrogenous and phosphatic fertilizer. Significant differences between sulphate of ammonia alone, and with the addition of superphosphate, occurred at both levels and showed that there was a definite phosphate response on the site of the trial. None of the treatments affected quality significantly.

None of the treatments had a significant effect on quality.

(*b*) *Dung, Nitrogen and Phosphate Trial At Chitedze*

This $3\times3\times3$ experiment was designed to test the effect of dung, nitrogen and phosphate on yield and quality of tobacco. The nitrogen dressing was applied to sub-plots either all at planting or half at planting and half four week's later.

TABLE VI

Dark Tobacco—Dung, N,P Trial

(A basic dressing of 80 lb. per acre muriate of potash to all plots)

Treatment	*Yield (lb./acre)*	*Grade Index*	*Crop Index*
(i) *Dung*			
Nil	1,131	23.35	26,409
5 tons per acre (112 lb. N)	1,328	23.88	31,713
10 tons per acre (224 lb. N)	1,313	23.59	30,974
(ii) *Nitrogen as Sulphate of Ammonia*			
Nil	959	24.47	23,467
50 lb. N per acre	1,302	23.65	30,792
100 lb. N. per acre	1,511	22.69	34,285
(iii) *Phosphate as Superphosphate*			
Nil	1,189	21.61	25,694
38 lb. P_2O_5 per acre	1,291	24.53	31,668
76 lb. P_2O_5 per acre	1,291	24.67	31,849
Mean	1,257	23.60	—
L.S.D. (P=0.05)	127	4.35	—
Coeff. of Varn.	14.2%	25.9%	—

Chemical Analysis of Dung

Percentage Nitrogen	*Percentage Phosphate* (P_2O_5)	*Percentage Potash* (K_2O)
0.99	0.22 (0.50)	0.37 (0.44)

Yield was significantly increased by applying five tons of dung whilst ten tons did not increase the yield any further. Applying nitrogen as sulphate of ammonia significantly increased yield at both the levels applied. It can be seen that nitrogen applied as sulphate of ammonia had a greater effect on yield than when it was applied as dung. None of the main treatments had any significant effect on quality.

Splitting the application of nitrogen did not significantly affect yield or qualit y Applying superphosphate did not have any effect on yield or quality.

(*c*) *N.P. Fertilizer Trials*

A series of 3 × 3 fertilizer trials were carried out at Chitedze and on two neighbouring estates. The object was to try to correlate fertilizer responses with soil type.

TABLE VII

Dark Tobacco N P Trials

Soil Analysis (0–6″)

Site	pH	*Per cent. Sand*		*Per cent. Silt*	*Per cent. Clay*	*Per cent. Nitrogen*	*Avail. Phosphate* (ppm)*	*Per cent. Potash*	*Per cent. Base Sat.*
		Coarse	*Fine*						
Chitedze (Block C) (Sandy Clay Loam)	6.5	42	18	8	31	0.155	6	0.22	92
Lingadzi Estate Site 1 (Sandy Clay)	5.4	32	12	9	45	0.138	4	0.36	51
(Lingadzi Estate Site 2 (Sandy Clay Loam)	6.4	46	18	8	27	0.137	7	0.21	94
Namitete Estate (Sandy Clay Loam)	5.7	42	18	6	33	0.111	13	0.07	60

*Determined by Brays method

TABLE VIIB

Yield per acre Cured Leaf (lb.)

Treatment	*Chitedze*	*Lingadzi (Site 1)*	*Lingadzi (Site 2)*	*Namitete*
(i) *Nitrogen as Sulphate of Ammonia*				
Nil	1,103	312	527	295
30 lb. N/acre	1,324	444	589	567
60 lb. N/acre	1,471	651	683	677
(ii) *Phosphate as Superphosphate* (19% P_2O_5)				
Nil	1,231	497	511	448
46 lb. P_2O_5/acre	1,315	428	618	542
92 lb. P_2O_5/acre	1,351	481	671	548
Mean	1,299	469	600	513
L.S.D. (P=0.05)	209	126	154	80
Coeff. of Varn.	16.1%	20.2%	25.7%	15.5%

The yield of tobacco on estates was very disappointing. At Lingadzi Estate early weed competition and much supplying must have affected yields, whilst at Namitete Estate the crop was very badly attacked by *Alternaria* leaf spot. This probably greatly affected the levels of response to the applied fertilizer.

At Chitedze there was a significant response to 30 lb. but no further response to 60 lb. per acre nitrogen. On two of the estates the yield response to nitrogen was at both levels, and on the other only at 60 lb. per acre. A significant yield response to phosphate was obtained at Lingadzi Estate (site 2) and Namitete Estate.

TABLE VIIC

Grade Index

Treatment	*Chitedze*	*Lingadzi (Site 1)*	*Lingadzi (Site 2)*	*Namitete*
(i) *Nitrogen as Sulphate of Ammonia* (20%N)				
Nil	42.50	16.72	15.53	10.54
30 lb. N/acre	48.54	18.17	16.00	11.21
60 lb. N/acre	48.05	18.21	17.72	10.32
(ii) *Phosphate as Superphosphate* (19% P_2O_5)				
Nil	49.00	16.86	16.32	10.57
46 lb. P_2O_5/acre	45.65	16.68	15.77	10.32
92 lb.	44.45	19.56	16.70	11.19
Mean	46.36	17.70	16.34	10.69
L.S.D. (P=0.05)	6.86	2.60	3.58	0.65
Coeff. of Var.	14.8%	10.9%	22.0%	60.5%

The quality of tobacco from the estate trials was also disappointing. Nitrogen, in all trials, did not have a significant effect on quality, and only on Lingadzi Estate did phosphate, at the rate of 92 lb. P_2O_5 per acre, improve quality.

Burley Tobacco

Except where otherwise stated all experiments have been conducted at Chitedze Agricultural Research Station on a red/brown sandy clay loam, showing adequate amounts of nitrogen and potash but a rather low phosphate status.

The main emphasis in burley tobacco experimentation over the past three years as been on the examination of various factors possibly influencing the production of " coloury " burley which is a light, cinnamon coloured, leaf looked for by the tobacco buyers. It has been previously shown that a well fertilized and well grown crop, although it may produce a lower percentage of " coloury " leaf gives a higher gross weight of " coloury " per acre than a lower yielding less heavily fertilized crop with a higher percentage of " coloury " in it. Examination of the return from sale of leaf grown at the Agricultural Research Station over the three year period shows that no price differential existed between the " coloury " and heavier " red " leaf. Yields from experimental treatments have, this season, reached 2,600 lb. of cured leaf per acre and, as long as good quality, red leaf continues to produce prices comparable with those for " coloury ", high yielding crops of overall good quality should be more profitable than lower yielding crops with a higher percentage of " coloury " leaf. The results of the experiments reported below should be considered in relation to this general observation. The difference between the percentage " coloury " plus the percentage " red " and one hundred per cent. in the tables is accounted for by the lower grades of leaf which are not subdivided into those two classes for commercial grading.

1. VARIETY TRIAL

Six varieties which in previous seasons had given consistently good yields of quality leaf were again tested to prove their reliability in any type of season, using a randomized block layout.

TABLE VIII

Burley Tobacco Variety Trial at Chitedze

(Fertilizer:—200 lb./acre " C " Mixture (6:18:12)
200 lb./acre sulphate of ammonia (20%N))

Variety	*Yield (lb./ acre)*	*Grade Index*	*Crop Index*	*Per cent Coloury*	*Per cent Red*
Barnet Special	1,907	62.59	119,383	26.6	59.7
Kentucky 16	1,977	57.46	113,629	15.8	68.2
Stand Upright	1,755	62.21	109,196	20.6	67.8
Green Briar	1,667	65.32	108,867	28.5	61.8
Burley 1	1,868	52.93	98,861	20.0	62.0
Burley 21	1,844	50.46	93,065	28.0	47.3
Mean	1,836	58.49	—	23.3	61.1
L.S.D. (P=0.05)	142	3.30	—	5.1	4.4
Coeff. of Variation	7.6%	5.6%	—	21.6%	7.0%

Barnet Special and Kentucky 16 gave significantly higher yields per acre than did Stand Upright and Green Briar. The quality of leaf produced by Barnet Special, Green Briar and Stand Upright was superior to that of Kentucky 16; all four varieties being markedly better than Burley 1 and Burley 21 which are two recent importations from Canada. Barnet Special, Green Briar and Burley 21 gave higher proportions of coloury leaf than did Stand Upright, Burley 1 and Kentucky 16, the latter varieties having higher proportions of red leaf.

Considering these results and those of previous seasons, Barnet Special is now recommended as the best variety of burley available to Nyasaland growers.

2. CULTURAL TRIALS

(*a*) *Topping and Spacing trial*

Critical evidence on the effect of different types of topping on burley production was lacking, although a certain amount of data was available on various topping procedures for Western tobacco grown in the same areas.

This trial was designed to demonstrate the responses of burley to various types of topping, applied at different stages in the growth of the plant. With this was incorporated a spacing trial and all factors were examined to determine their value in producing coloury leaf, the experimental design being a $3\times3\times3$ factorial.

TABLE IX

Burley Tobacco—Topping and Spacing Trial at Chitedze

(Fertilizer:—200 lb. per acre "C" Mixture (6:18:12)
200 lb. per acre sulphate of ammonia)

Treatment	*Yield (lb./ acre)*	*Grade Index*	*Crop Index*	*Per cent Coloury*	*Per cent. Red*
Type of topping:					
(*a*) No topping	2,531	49.34	124,894	23.2	35.2
(*b*) Medium topping (flower+3 leaves)	2,553	54.15	138,230	24.8	47.3
(*c*) Low topping (flower+6 leaves)	2,437	54.53	132,905	22.4	49.2
Time of topping:					
(*a*) Bud topping	2,513	53.75	135,053	22.3	44 7
(*b*) Top at first flower	2,539	53.54	135,935	24.9	44.1
(*c*) Top at full flower	2,470	50.71	125,240	23.1	43.5
Spacing:					
(*a*) 3′ (Ridge)× 2′ (Plant)	2,188	53.50	117,081	20.7	46.3
(*b*) 3′ (Ridge)×1½′ (Plant)	2,671	54.11	144,509	23.6	44.6
(*c*) 3′ (Ridge)×1′ (Plant)	2,662	50.41	134,201	26.1	41.4
Mean	2,507	52.67	—	23.5	44.0
L.S.D. (P=0.05)	169	3.81	—	4.6	6.2
Coeff. of Variation	9.8%	10.6%	—	28.4%	20.5%

Time of topping had no effect on the yield and quality of the leaf produced. Plants which were not topped gave a lower quality leaf than those from which the flowering shoot plus either three or six leaves were removed; such untopped plants giving a significantly lower percentage of " red " leaf than topped plants although no effect on the percentage of " coloury " leaf was evident.

Close spacing ($3'\times1'$ or $3'\times1\frac{1}{2}'$) gave a higher yield per acre than did the more conventional $3'\times2'$ spacing.

(*b*) *Time of Planting trial*

The lack of proper barn accommodation causes many growers to delay planting until well after the first rains. There is conclusive proof that such a procedure results in lower yields and poor quality leaf. It has been argued, however, that the benefits of early planting may not be lost if, instead of trying to cure leaf in poor, leaking but inexpensive barns the leaf is allowed to yellow completely on the plant. Such over-ripe leaf could then be cured, as the rains have almost abated, when less reliance need be placed on the condition of the barns. This 3×3 factorial experiment was designed to examine these theories and to determine if such practices could influence the amount of " coloury " leaf produced,

TABLE X

Burley Tobacco—Time of Planting and Harvesting trial at Chitedze

(Fertilizer:—200 lb. per acre "C" Mixture (6:18:12)
200 lb. per acre sulphate of ammonia (20%N))

Treatment	*Yield (lb./ acre)*	*Grade Index*	*Crop Index*	*Per cent. Coloury*	*Per cent. Red*
Time of Planting					
(*a*) 28th November	1,995	57.01	113,752	16.5	56.7
(*b*) 19th December	1,643	59.78	98,197	24.4	50.9
(*c*) 13th January	1,107	40.09	44,366	20.3	36.1
Condition at Harvest					
(*a*) Ripe	1,608	52.57	84,516	20.4	51.1
(*b*) Under-ripe	1,559	52.73	82,201	19.2	45.7
(*c*) Over-ripe	1,578	51.58	81,393	21.7	46.9
Mean	1,581	52.29	—	20.4	47.9
L.S.D. (P=0.05)	303	3.57	—	6.3	6.3
Coeff. of Variation	19.2%	6.8%	—	30.7%	13.1%

The significant depression in yield with delaying planting either to mid-December or mid-January was clearly evident. The earlier plantings (28th November and 19th December) were of better quality than the late planting (13th January). The amount of red leaf fell appreciably with the late planting but this could have been due to the amount of small leaves (under 19 inches) of low quality produced from a late planted crop. The time of planting did not have a significant effect on the amount of coloury leaf produced, although the yield summary suggests significance. The " F " test was not significant.

No evidence that the condition of the leaf at harvest materially affected yield, quality or the amount of coloury leaf produced was found. The dry, favourable season, probably evened out the expected differences between treatments. No interaction reached significance.

3. FERTILIZER TRIALS

(*a*) *Nitrogen and Dung*

From an observational plot it seemed that where dung had been applied the amount of leaf spot caused by *Cercospora nicotianae* was reduced. To examine this a 3×3 factorial experiment was laid down with three levels of dung application (nil, 5 tons per acre, 10 tons per acre) with three levels of nitrogen dressings (30, 50 and 70 lb. per acre). It had been hoped to measure the amount of spot damage on each treatment but the disease incidence was too low to do so.

TABLE XI

Burley Tobacco—Effect of Nitrogen and Dung at Chitedze

(Fertilizer:—200 lb. per acre "C" Mixture (16:18:12) as a basic dressing to all treatments)

Treatment	*Yield (lb./ acre)*	*Grade Index*	*Crop Index*	*Per cent. Coloury*	*Per cent. Red*
(*a*) *Nitrogen as Sulphate of Ammonia* (20%*N*)					
30 lb. N/acre	2,018	53.57	117,726	16.9	70.2
50 lb. N/acre	2,216	57.38	115,169	16.5	65.6
70 lb. N/acre	2,161	54.91	120,681	19.3	63.7
(*b*) *Dung (tons per acre)*					
Nil	2,120	55.52	108,098	18.1	65.7
5	2,105	54.72	127,153	19.0	65.3
10	2,170	55.62	118,662	15.6	68.5
Mean	2,132	55.29	—	17.6	66.5
L.S.D. (P=0.05)	182	2.83	—	5.2	6.1
Coefficient of Variation	8.5%	5.1%	—	29.4%	9.1%

Chemical Analysis of Dung

Percentage Nitrogen	*Percentage Phosphate (P_2O_5)*	*Percentage Potash (K_2O)*
0.99	0.22 (0.50)	0.37 (0.44)

Dung at the various levels had no influence on yield, quality (grade index), per cent. coloury or per cent. red leaf produced.

Nitrogen at the rate of 250 lb. per acre sulphate of ammonia improved the grade index of the leaf but at 350 lb. per acre it reduced leaf quality to the level of the nil treatment.

(*b*) *Sources of Nitrogen*

The problem of continual sulphate of ammonia application affecting the acidity of the main tobacco growing soils of Central Nyasaland has been increasing over the years. This experiment was designed to determine the effect, if any, on burley tobacco of replacing the usually recommended sulphate of ammonia by either nitrate of soda or nitromoncal applied at rates equivalent to 20, 40 or 60 lb. of nitrogen per acre. The design was a 3×3 factorial and the nitrogen dressing was applied to split plots either all at planting or half at planting and half four weeks later.

TABLE XII

Burley Tobacco—Sources of Nitrogen Trial at Chitedze

(Fertilizer:—200 lb. per acre superphosphate and 80 lb. per acre muriate of potash as a basic dressing to all treatments)

Treatment	*Yield (lb./acre)*	*Grade Index*	*Crop Index*	*Per cent. Coloury*	*Per cent. Red*
(*a*) *Sources of Nitrogen*					
Sulphate of Ammonia (20%N)	2,171	61.21	132,905	19.6	52.3
Nitromonocal (20.5% N_2)	2,086	58.78	122,609	20.1	50.9
Nitrate of Soda (16% N_2)	2,091	59.66	124,753	22.2	52.0
(*b*) *Levels of Nitrogen*					
20 lb. per acre	2,088	59.74	124,763	23.4	51.5
40 lb. per acre	2,068	60.27	124,623	21.1	53.7
60 lb. per acre	2,192	59.64	130,734	17.4	50.1
L.S.D. (=0.05)	169	3.12	—	3.7	3.8
Coeff. of Variation	11.3%	7.4%	—	25.6%	10.3%
(*c*) *Time of Nitrogen Application*					
At planting	2,118	59.23	125,426	20.4	52.1
Half at planting }	2,115	60.54	128,015	20.8	51.4
Half at four weeks }					
Mean	2,116	59.88	—	20.6	51.8
L.S.D. (P=0.05)	112	1.58	—	1.8	2.2
Coeff. of Variation	9.3%	4.7%	—	15.2%	7.4%

The various fertilizers used had no effect on yield, quality or the percentages of coloury and red leaf produced. When nitrogen was applied at 60 lb. per acre the amount of coloury leaf produced fell significantly as compared with lower applications of nitrogen. No benefit was shown in splitting the nitrogen dressing rather than applying it all at planting.

(*c*) *Nitrogen Phosphate Trials*

A series of 3×3 nitrogen-phosphate trials were conducted at the Agricultural Research Station and on two neighbouring estates, on as wide a range of soil types as possible.

TABLE XIIIA

Burley Tobacco—NP Trials

6A Soil Analysis (0–6″)

Site	pH	*Per cent. Sand*		*Per cent. Silt*	*Per cent. Clay*	*Per cent. Nitrogen*	*Available Phosphate* *(p.p.m.)	*Per cent. Potash*	*Per cent. Base Sat.*
		coarse	*fine*						
Chitedze Block E .. (Sandy clay loam)	6.05	48	20	5	27	0.124	16	0.25	98
Mbabzi Estate (site 1) (Sandy clay to sandy clay loam)	6.40	35	16	12	35	0.137	10	0.42	79
Mbabzi Estate (site 2) (Sandy clay loam)	6.40	38	20	11	30	0.161	6	0.23	90
Kakuyu Estate (site 1) (Sandy clay)	6.10	28	18	11	43	0.176	6	0.25	75
Kakuyu Estate (site 2) (Sandy loam)	6.25	54	2	7	16	0.138	8	0.05	86

*Determined by Bray's method

TABLE XIIIB

Yield per acre Cured Leaf (lb.)

Treatments	*Chitedze*	*Kakuyu (Site 1)*	*Kakuyu (Site 2)*	*Mbabzi (Site 1)*	*Mbabzi (Site 2)*
(a) Nitrogen as Sulphate of Ammonia					
Nil	1,236.6	958.8	517.7	701.3	789.4
30 lb./acre	1,491.2	1,117.7	579.3	1,124.2	993.1
60 lb./acre	1,670.1	1,057.7	787.7	1,097.8	1,287.3
(b) Phosphate as Superphosphate					
Nil	1,426.2	858.4	608.9	930.9	932.6
46 lb. per acre	1,540.6	1,110.0	620.9	1,045.6	1,083.0
92 lb. per acre	1,431.2	1,165.8	655.0	946.8	1,054.3
Mean	1,466.0	1,044.7	628.3	974.4	1,023.3
L.S.D. (P=0.05)	147.5	212.6	155.5	180.6	166.0
Coeff. of Variation	10.1%	20.4%	24.8%	18.5%	16.2%

TABLE XIIIC

Mean Grade Index

Treatment	*Chitedze*	*Kakuyu (Site 1)*	*Kakuyu (Site 2)*	*Mbabzi (Site 1)*	*Mbabzi (Site 2)*
(a) Nitrogen as Sulphate of Ammonia					
Nil	45.6	29.3	30.1	43.6	36.1
30 lb. per acre	50.2	31.9	34.3	46.7	43.0
60 lb. per acre	51.7	32.2	35.5	43.9	49.1
(b) Phosphate as Superphosphate					
Nil	48.0	31.4	34.5	43.7	41.5
46 lb. per acre	50.1	30.1	33.1	48.9	40.3
92 lb. per acre	49.4	32.0	32.3	41.6	46.5
Mean	49.2	31.2	33.3	44.7	42.8
L.S.D. (P=0.05)	5.4	3.5	4.4	8.5	4.1
Coeff. of Variation	11.1%	11.4%	13.3%	18.9%	9.6%

TABLE XIIID

Percentage Coloury Leaf

Treatment	*Chitedze*	*Kakuyu (Site 1)*	*Kakuyu (Site 2)*	*Mbabzi (Site 1)*	*Mbabzi (Site 2)*
(*a*) *Nitrogen as Sulphate of Ammonia*					
Nil	21.5	15.2	12.4	27.0	24.2
30 lb. per acre	20.5	15.1	14.1	23.8	28.1
60 lb. per acre	21.1	14.3	15.6	27.1	32.1
(*b*) *Phosphate as Superphosphate*					
Nil	19.1	15.5	15.4	26.3	27.4
46 lb. per acre	21.4	11.5	14.2	28.5	25.6
92 lb. per acre	22.6	17.5	12.5	23.1	31.4
Mean	21.0	14.9	14.0	26.0	28.1
L.S.D. (P=0.05)	7.6	4.1	5.5	7.1	6.0
Coeff. of Variation	36.3%	27.8%	39.5%	27.4%	21.2%

TABLE XIIIE

Percentage Red Leaf

Treatment	*Chitedze*	*Kakuyu (Site 1)*	*Kakuyu (Site 2)*	*Mbabzi (Site 1)*	*Mbabzi (Site 2)*
(*a*) *Nitrogen as Sulphate of Ammonia*					
Nil	52.2	34.7	29.7	39.9	27.6
30 lb. per acre	61.0	40.7	38.2	43.4	35.5
60 lb. per acre	64.2	40.8	40.9	35.0	37.0
(*b*) *Phosphate as Superphosphate*					
Nil	59.1	32.3	32.1	39.8	34.2
46 lb. per acre	58.9	38.5	37.2	40.0	34.0
92 lb. per acre	59.4	45.3	39.5	38.5	31.9
Mean	59.1	38.7	36.3	39.5	33.4
L.S.D. (P=0.05)	8.2	6.0	7.7	7.1	6.0
Coeff. of Variation	14.0%	15.4%	21.4%	19.7%	18.1%

Statistically the results show that only on Kakuyu estate (site 1) was there a definite yield response to phosphate at the rate of 250 lb. superphosphate per acre. This had in fact been predicted, following an examination of the soil analysis, and a response had also been expected on Mbabzi estate (site 2). Examination of the results of this trial shows that 500 lb. per acre superphosphate did in fact statistically improve the quality. From the yield figures it can be seen that 250 lb. per acre superphosphate did improve yields almost up to the significant level.

The application of nitrogen significantly increased yields in four out of five trials. On soils which will not grow good quality tobacco without additional nitrogenous fertilizer, the addition of nitrogen not only increased the yields but also improved the grade index. In most cases there was also a higher percentage of red leaf where there was additional nitrogen. One experiment was exceptional in that there was an increase of coloury leaf with higher nitrogen.

4. EXTRACT FROM REPORT OF THE AGRICULTURAL CHEMIST, CHITEDZE

Leaf Analysis of Burley Tobacco

With the object of obtaining the maximum information from the fertilizer experiments a series of samples of "red" and "coloury" leaf (19–23") were taken from the various treatments and analysed for the major elements. It was thus hoped to show the main chemical differences between "red" and "coloury" leaf and see how these differences were affected by different fertilizer treatments. The figures obtained were analysed statistically.

TABLE XIV

Effect of Nitrogen and Dung at Chitedze (*see Burley tobacco para.* 3 (*a*))

(Fertilizer:—200 lb. " C " Mixture per acre as a basic dressing to all plots)

Treatments	*Coloury Leaf*			*Red Leaf*		
	Per cent. N	*Per cent.* P	*Per cent.* K	*Per cent.* N	*Per cent.* P	*Per cent.* K
(i) *Dung*						
0. Nil	2.63	.25	7.74	3.17	.24	5.96
1. 5 tons/acre	2.54	.29	7.75	3.10	.25	6.23
2. 10 tons/acre	2.79	.30	7.43	3.31	.26	6.45
(ii) *Nitrogen*						
0. 30 lb. N/acre	2.47	.31	8.21	3.04	.25	6.38
1. 50 lb. N/acre	2.52	.30	7.61	3.07	.26	6.24
2. 70 lb. N/acre	2.97	.23	7.11	3.48	.24	6.01
Mean	2.65	.28	7.64	3.20	.25	6.21
L.S.D. (P=0.05) ..	0.12	0.03	0.40	0.12	0.05	0.30
Coeff. of Varn.	3.5%	8.0%	3.9%	2.8%	8.0%	3.6%

Combined Statistical Analysis of Red and Coloury Leaf

	Per cent. N	*Per cent.* P	*Per cent.* K
Coloury Leaf	2.65	.28	7.64
Red leaf	3.19	.25	6.21
Mean	2.92	.27	6.93
L.S.D. (P=0.05)	0.08	0.01	0.26
Coeff. of Varn.	4.0%	5.3%	5.4%

The effect on coloury leaf of increasing the rate of dung was to increase the percentage of nitrogen and phosphate in that leaf. As far as " red " leaf was concerned the effect on nitrogen percentage was similar but the phosphate level remained unchanged and the potash level showed an increase.

Applying fertilizer nitrogen had the same effect as dung on the percentage nitrogen in both " red " and " coloury " leaf. It reduced the percentage of phosphate and potash in " coloury " leaf and in " red " leaf reduced the potash level only.

In this experiment " red " leaf contained significantly more nitrogen and significantly less phosphate and potash than " coloury " leaf.

TABLE XV

Sources of Nitrogen Trial at Chitedze (*see Burley tobacco para.* 3 (*b*).)

(Fertilizer:—200 lb. superphosphate and 80 lb. per acre muriate of potash as a basic dressing to all plots)

Treatments	*Coloury Leaf*			*Red Leaf*		
	Per cent. N	*Per cent.* P	*Per cent.* K	*Per cent.* N	*Per cent.* P	*Per cent.* K
(i) *Sources of Nitrogen*						
0 Sulphate of Ammonia ..	2.82	.22	7.05	3.26	.21	5.34
1 Nitromoncal	2.93	.22	6.84	3.14	.23	5.40
2 Nitrate of Soda	2.88	.22	6.72	3.21	.22	5.41
(ii) *Rates of Nitrogen*						
0 20 lb. N/acre	2.69	.23	7.02	3.04	.23	5.64
1 40 lb. N/acre	2.91	.22	6.77	3.09	.22	5.49
2 60 lb. N/acre	3.03	.21	6.83	3.48	.21	5.02
Mean	2.88	.22	6.87	3.20	.22	5.38
L.S.D. (P=0.05) ..	0.17	—	0.41	0.09	—	0.46
Coeff. of Variation ..	4.6%	—	4.7%	2.1%	—	6.5%

Combined Statistical Analysis of Red and Coloury Leaf

	Per cent. N	*Per cent.* P	*Per cent.* K
Coloury leaf	2.88	.22	6.87
Red leaf	3.20	.22	5.38
Mean	3.04	.22	6.12
L.S.D. (P=0.05)	0.08	—	0.21
Coeff. of Varn.	3.6%	—	5.2%

The only effect of the various sources of nitrogen on " coloury " and " red " leaf was that nitromoncal gave a lower percentage of nitrogen in the red leaf than either sulphate of ammonia or nitromoncal.

Increasing the amount of nitrogen applied increased the percentage of nitrogen in both " coloury " and " red " leaf. There was no effect on the percentage phosphate in " red " or " coloury " leaf and only in " red " leaf was the amount of potash significantly affected; the higher nitrogen rate giving a lower potash content.

The " coloury " leaf contained significantly less nitrogen and more potash than " red " leaf, whilst the amount of phosphate did not differ.

TABLE XVI

Nitrogen Phosphate trial at Chitedze (*see Burley Tobacco para.* 3 (*c*).)

(Fertilizer:—A basic dressing of 80 lb. per acre muriate of potash to all plots)

Treatments	*Coloury Leaf*			*Red Leaf*		
	Per cent. N	*Per cent.* P	*Per cent.* K	*Per cent.* N	*Per cent.* P	*Per cent.* K
(i) *Rates of Nitrogen*						
0 Nil	2.23	.48	8.62	2.52	.46	8.35
1 30 lb. per acre	2.25	.42	8.31	2.64	.40	7.99
2 60 lb. per acre	2.43	.35	8.24	2.90	.34	7.62
(ii) *Rates of Phosphate*						
0 Nil	2.42	.37	8.56	2.67	.41	7.96
1 46 lb. per acre	2.27	.39	8.32	2.74	.38	8.06
2 92 lb. per acre	2.23	.48	8.29	2.65	.42	7.93
Mean	2.30	.41	8.39	2.69	.40	7.98
L.S.D. (P=0.05) ..	0.11	.02	0.50	0.09	.05	0.55
Coeff. of Variation ..	3.5%	3.3%	4.5%	2.4%	8.6%	5.2%

	Per cent. N	*Per cent.* P	*Per cent.* K
Coloury leaf	2.30	0.41	8.39
Red leaf	2.69	0.40	7.98
Mean	2.49	0.40	8.18
L.S.D. P=(0.05)	0.06	0.03	0.26
Coeff. of Variation ..	3.2%	10.9%	4.6%

In this experiment the higher rate of nitrogen again increased the amount of nitrogen in both types of leaf whilst the percentages of phosphate fell for both " red " and " coloury " leaf. The decreased percentage of potash in " red " leaf resulting from the addition of more nitrogen confirms the results of the other analyses.

Applying phosphate significantly reduced the percentage nitrogen in " coloury " but not " red " leaf and increased the amount of phosphate in " coloury " but not " red " leaf. Varying the rate of phosphate applied did not affect the percentage potash in either " red " or " coloury " leaf.

Again it can be seen that " coloury " leaf contained less nitrogen, more potash and the same amount of phosphate as " red " leaf.

GENERAL CONCLUSIONS

" Coloury " leaf contains less nitrogen than " red " leaf and where various rates of nitrogen are applied the lowest percentage nitrogen in " red " leaf is always above the highest percentage in " coloury " leaf, in any one experiment. This does not however mean that all leaf containing above a certain percentage of nitrogen will be " red ", as a comparison of the nitrogen percentages in Table IX with those in the first two tables shows.

" Coloury " leaf contained more potash than " red " leaf, even when the rate applied (as dung) was varied.

The difference in phosphate level in " red " and " coloury " leaf, if existing, is very small.

Increasing the amount of nitrogen applied increases the percentage nitrogen in coloury and red leaf.

When the amount of phosphate in " red " and " coloury " leaf is low (Table XV) additional nitrogen has no effect but when it is higher (Tables XIV and XVI) increasing the amount will reduce the percentage phosphate.

Applying nitrogen reduces the percentage potash in red leaf but has a variable effect in coloury leaf.

Turkish Tobacco

1. FERTILIZER TRIALS AT MBAWA

Two $2\times2\times2\times2$ experiments were carried out at Mbawa, Northern Province, on two soil types to try to determine the response of Turkish tobacco to fertilizers. Details of the soil analyses are given below.

TABLE XVII

Turkish Tobacco—Soil Analyses

	pH	Per cent. Sand		Per cent. Silt	Per cent. Clay	Per cent. Nitrogen	Available Phosphate (ppm.)*	Per cent. Potash	Per cent. Base Sat.
		Coarse	Fine						
Experiment 1 (Red)	5.30	36	39	6	18	0.064	Not Available	0.23	58
Experiment 2 (Grey loamy sand) ..	6.00	54	30	5	10	0.035	15*	0.11	61

*Determined by Brays method.

TABLE XVIII

Turkish Tobacco—Yield of Cured Leaf (lb./acre)

Fertilizer	Red Soil	Grey Soil*
Nil	860	743
19 lb. Nitrate of soda per acre	708	805
15 lb. Sulphate of ammonia per acre	826	646
150 lb. Superphosphate per acre	1,051	856
75 lb. Muriate of potash per acre	849	785
Mean (whole experiment)	916	786
L.S.D. (P=0.05)	274	228
Coeff. of Varn.	17.9%	17.3%

*Experiment received a uniform top dressing of 5 lb. nitrogen per acre.

In the table of results, only main treatments have been given as none of the interactions reached statistical significance.

On the red soil only 150 lb. per acre superphosphate increased yield considerably, although not quite significantly over the nil treatment. None of the treatments significantly affected yield on the grey soil.

2. VARIETY TRIALS

A replicated trial set out and planted at Mzimba had to be abandoned, but four random plots were harvested and bulked before weighing. The results of this observation trial were as follows:

Variety	Total area harvested	Yield	Yield per acre
Soulouk	30ft. × 48ft.	27 lb.	817 lb.
Samsoun	30ft. × 48ft.	31 lb.	938 lb.
Djanik	30ft. × 48ft.	8 lb.	242 lb.

3. SOULOUK

A one-acre plot was established at Mzimba, and after poor weather conditions and late harvesting (due to the Emergency) approximately 700 lb. cured leaf was harvested of which 450 lb. was sent to Salisbury, and sold at an average price of 31.85d.

Extract from Report of the Agricultural Chemist, Bvumbwe

LEAF COMPOSITION

Samples of " slaty " and " cherry red " leaf were analysed from one estate. It was found that the " slaty " tobacco had a higher chlorine (1.1 per cent.) content than normal leaf (0.7 per cent). The difference is not very large but it was fairly consistent and may be connected with the cause of " slatiness ".

A fertilizer experiment using nitrogen, phosphorus and potassium was planted at Chaone Estate on a late ploughed sandy loam. The trend of the yields was similar to last year's experiment but this year there were no significant differences. There was a heavy infestation of eelworm on the experiment and it is possible that this may have been responsible for the lack of significance.

COTTON

REPORT OF THE COTTON SPECIALIST (E.C.G.C.)

Cotton Breeding

ALBAR 51

Multiplication of Albar 637 has yielded some 160 tons of seed, which is to be distributed in the market areas round Chikwawa in 1959/60. Red bollworm caused considerable loss of crop at Toleza; Chapananga was comparatively free from insect damage, but showed a fairly heavy infection of angular leaf spot in February and early March. The infected leaves were soon shed, and very few bacterial stem lesions developed; CLB in the adjacent market area showed considerable stem infection.

TABLE I

Meteorological Data—Makanga

Month 1958	*Rainfall*		*Humidity %*		*Temperature*		*Sunshine*	*Evap.*
	ins.	*Days*	6 a.m.	2 p.m.	*Max.*	*Min.*	*hrs./day*	*ins.*
April	.18	3	97	51	90.7	67.7	9.7	6.58
May	.18	4	97	51	86.9	60.4	8.9	5.35
June	.69	10	97	56	81.1	57.0	5.6	3.69
July	.16	4	96	50	80.8	52.5	6.6	4.68
August	.73	4	96	39	84.0	53.9	7.8	5.53
September	.15	2	89	37	93.4	65.6	8.4	7.87
October	.12	2	86	38	96.7	70.3	7.9	9.62
November	1.86	3	84	41	99.7	73.9	8.8	9.94
December	3.85	12	86	44	95.6	74.0	7.6	8.31
1959								
January	8.25	14	95	54	91.6	71.6	7.2	6.40
February	9.53	11	98	53	89.3	72.8	5.7	4.97
March	3.58	8	97	57	89.5	69.3	8.6	6.30
April	.41	2	95	54	90.0	65.9	9.9	5.73
May	—	—	95	44	91.9	60.8	9.7	6.36
June	.24	3	96	48	84.3	56.7	7.8	3.94
July	.69	5	96	48	83.7	57.0	7.5	4.77
August	.76	5	93	38	87.0	56.6	8.9	5.92
September	.16	1	88	38	89.7	63.1	8.3	7.76
Means	1:1 limits							
	Lower	Upper	(13 years)		(15 years)		(4 yrs.)	(5 yrs.)
October	—	—	74	35	97.3	70.0	8.6	10.32
November	1.77	4.72	78	43	96.1	72.3	8.3	9.78
December	4.20	7.79	82	56	92.5	72.1	7.0	6.38
January	3.68	9.17	89	64	91.6	72.2	6.4	6.08
February	3.28	8.85	90	63	90.7	72.2	6.6	5.41
March	2.49	5.15	91	62	88.4	70.8	8.2	5.81
April	.37	2.06	90	57	88.6	67.3	8.3	5.70
May	—	—	90	52	84.9	60.6	8.4	5.18
June	—	—	87	54	80.7	54.7	6.9	3.94
July	—	—	89	47	82.1	54.4	7.7	4.58
August	—	—	87	43	85.6	56.7	8.3	5.66
September	—	—	78	40	91.7	62.8	7.9	7.71

In six variety trials, A.637 averaged 71 lb. more lint per acre than CLB, an increase of 19 per cent.

Single Plant Selections.—21 direct selections from Albar 637 and the related Albars were tested in trials; six of these equalled or exceeded A.637 in yield; their standard of jassid resistance is higher, but jassid attack was not important this year. 36 selections out of the 80 grown this season are being carried on for trial in 1959–60. Of the three Uganda selections, Albar (56) 6 and 23 both yielded well (Table II).

TABLE II

Cotton Variety Trials

Lint Yields in lb./acre

Variety	*Makanga*	*Ngabu*	*Chitala*	*Lower River*
CLB	303	566	242	363
A.637	372	553	291	429
ABC.31	289	—	—	—
40	302	434	267	356
109	274	—	—	—
146	363	527	292	372
AC. 31	354	507	294	394
A(56)16	344	—	292	406
22	320	572	214	358
23	358	594	285	400
UPA(56)6	402	555	312	433
S.E.	± 21.7	± 32.1	± 11.4	± 16.1
Sign. Diff.	61	91	32	46
C. of Var.	17%	13%	11%	15%
Replications	6	4	6	28(12)
Planted	17–12–58	—	19–12–58	various

Plot Size 1/145 acres. Spacing 3 ft. × 2 ft., 3 plants/hole. Station trials 5 × 5 lattices; district plots consisted of a single replication of the controls in each garden, with three of the other seven varieties arranged in balanced incomplete blocks.

ALBAR CROSSES

Three of the Albar 49 crosses are being retained for further testing (ABC.40, ABC.146, and AC.31, Table II). UPA(56)5 from Uganda has yielded consistently well; it is below the standard of jassid resistance required, but has shown some segregation for this character.

Selections were taken from the F_2 of the Albar 51 crosses made at Makanga in 1957; field selection was mainly based on jassid resistance. About 50 per cent. have been discarded on yield per plant and lint index, leaving 500 which will be tested for resistance to bacterial blight next year.

GINNING PERCENTAGE

Pickings taken at approximately ten day intervals showed a steep rise in ginning percentage after 2nd May, following very much the same pattern as last year. Much of the fall in seed weight on Makanga this year can be attributed to stainer damage; the grade 1 seed cotton from the last picking contained only 10 per cent. of viable seed.

TABLE III

Ginning Percentage of Uganda Selections

	Uganda	*Chitala*	*Makanga*	*Ngabu*
CLB	—	35.5	30.8	31.6
A. 637	(36–37)	37.0	31.1	32.6
UPA (56) 5	38.2	38.6	32.4	34.4
A (56)16	40.0	38.6	33.4	—
A (56)22	39.3	37.0	31.8	33.0
A (56)23	40.3	40.6	33.2	36.4

Low ginning percentages continue to be recorded in the Lower River (Table III). Under these conditions, however, the Uganda strains (chosen for their high ginning percentage) show a definite improvement over the other strains which are being grown; lint index is also higher.

SUDAN VARIETIES

Seed from four families of BAR.11/9, homozygous for $B_2B_3B_6$, were obtained from the Sudan, together with BARHOP.7, a cross between BAR.7/8.2 and Hopi Acala. In observation plots this year the yields were satisfactory; they grew to the same height as other varieties. There was little bacterial blight on the station, and their resistance to natural infection could not be assessed.

Husbandry and Rotation Crops

COTTON SHEDDING

Irrespective of time of planting, practically no fruit has been set in the last two seasons before mid-February, and the first bolls have opened in mid-April. A series of observation plots were given different treatments to see whether fruit setting was affected by variation in time of planting, spacing, topping, irrigation, etc. Only two of the treatments appeared to have any effect—spraying with a fruit drop hormone advanced the first picking date by two weeks, and a wider spacing by one week; spraying with insecticide had no effect. Only about one third of the shed buds and bolls showed signs of insect damage, and it would appear that the bulk of the shedding is physiological. Hormone spraying will be tested in a replicated trial next season.

The result of this shedding is that early planted cotton grows very tall and top heavy. This is an important factor in a year of early planting rains, and will be of even more importance if early planting with irrigation becomes possible on a large scale in the Elephant Marsh.

MANURING AND FERTILIZERS

Five replicated trials included various fertilizer and organic manurial treatments applied to cotton, maize, and groundnuts. As in previous seasons, there were no significant responses.

TABLE IV

Ridging and Mulching Trial

Makanga—LT. 3—Trial 4/2

Yield of Shelled Groundnuts in lb/acre

	No mulch	*Light mulch*	*Heavy mulch*	*Mean*
Flat	203	487	575	423
Ridged	278	483	634	466
Tie-ridged	531	614	617	589
Mean	358	529	610	
	Treatments		*Means*	
S.E.	± 43.9		± 25.4	
Sign. Diff.	126		73	
C. of Var.	22%			

Plot Size 1/81 acres. 3 × 3 factorial, 6 replications. Seed rate 150 lb./acre. Spacing 18″ × 9″. Planted 11th January, 1959.

MULCHING AND RIDGING

Trial 4/2 was planted with groundnuts this year (Table IV). Yields from tie-ridged plots were more than twice those from flat planting, and a heavy straw mulch had the same effect; the combination of these two treatments was not significantly better than either one by itself.

In trial 9/7, where mulching of maize was combined with supplementary irrigation, mulching gave a significant increase in yield. Soil temperatures at 3 inches below the soil surface showed less variation under the mulch: mean daily range was 81.0° to 82.5° during February and March; in the mulched plots it was 79.4° to 84.6°. The irrigation did not affect yield significantly; rainfall was adequate, and only 4 inches was applied.

ROTATION TRIALS

Trials 8/10 and 8/11 showed no significant differences in their second season; the treatments were described in last year's report.

COTTON-MAIZE INTERPLANTING

Local opinion among African cultivators still favours interplanting of cotton and maize on better land in the Lower River, although cotton has been grown only in pure stand since 1952. Earlier work has shown that cotton planted between normally spaced maize (3 feet between rows) gives very poor yields and ripens late; but that maize spaced at 6 and 9 feet between rows allows the cotton to grow very much better. These earlier experiments were carried out before 1952, and the cotton was usually planted in January or later; no pure stand maize was included to measure the effect of cotton on maize yields.

The earlier experiments, and observation plots planted in 1957/58, indicated that the planting of maize and cotton on alternate ridges might have economic possibilities under the present conditions of planting and uprooting of cotton. The results of a replicated trial this season (Table V) are even more favourable than was expected: from the same area of land, interplanting in this way has increased the yields of both maize and cotton.

TABLE V

Interplanting of Cotton and Maize

Makanga—Field 13—Trial 9/3 — *Yields in lb/acre*

	Seed Cotton	*Shelled Maize*
Cotton and Maize planted 18th December, 1958		
Pure stand	959	2904
Interplanted	1237	3755
Cotton planted 6th January, 1959; Maize 18th December, 1958		
Pure stand	905	2931
Interplanted	1032	3728
S.E.	± 39.9	± 137.7
Sign. Diff.	117	401
C. of Var.	14%	15%

Plot Size 1/48 acres. 6 replications of 8 treatments. Seed rate cotton 20 lb/acre; maize 15 lb/acre. Spacing cotton 3 ft. × 2ft.; maize 3ft. × 3ft.; both 3 plants/hole. Interplanting: alternate ridges cotton and maize.

The foothill area along the east bank of the Shire is better suited to maize than the main cotton growing areas to the west, where sorghum is the staple grain crop.

Cotton production in the former (east bank) area has declined sharply since 1952, and it is possible that interest in cotton would revive if interplanting with maize were allowed.

APPENDIX

Origin and Special Characteristics of the Main Cotton Strains Mentioned

CLB.	Crown Land Bulk, the commercial variety of Nyasaland, mainly of U.4 origin
CL.20	A selection from CLB., with longer and finer lint
A.637	An Albar 51 selection ex Uganda, which is being multiplied to replace CLB. in Nyasaland
A.629, A.640, A.474	Albar 51 selections ex Uganda
ABC.30, etc.	Selections made in 1955 from the F_4 of a cross (Albar 49 × BP.52) × CL.20
AC.31	A selection made in 1955 from the F_4 of a cross Albar 49 × CL.20
A(56)16, etc.	Albar 51 selections made at Namulonge in 1956, showing high ginning percentage
UPA(56)5	A selection made at Namulonge in 1956 from hybrid material (MU.8 × BP.52[2]) × Albar 51
BAR.11/9	BAR.11/7 with B_6 added
BAR.7/8.2	BAR. SP.84, carrying B_2 and B_3 ex Uganda SP.84
Hopi Acala	A very early type from U.S.A., of high fibre strength

Extract from Report of the Agricultural Chemist, Bvumbwe

COTTON

COTTON SEED FACTORY

Most of the work on cotton seed has been connected with the opening of the cotton seed oil factory to process about 5,000 tons of seed per year. This is operated in Blantyre by Nyasaland Oil Industries, in which the Agricultural Production and Marketing Board have a controlling interest.

(a) Stored Seed

The delays in completing the factory meant that stocks of seed had been held from the 1956 and 1957 crops. These were examined to assess their suitability for pressing. Their oil content was 37–38 per cent., the free acid in the 1956 oil being 25 per cent. and in the oil extracted from the 1957 seed, 3.8 per cent.

(b) Cotton Seed Soap Stock

The practicability of utilizing the resultant soap stock from cotton seed oil neutralization was considered. Soaps which had incorporated such stock were obtained from Portuguese East Africa and Uganda, and tested for compliance with the Nyasaland Government Soap Ordinance. They were found to contain 55 per cent. and 46 per cent. fatty matter with a maximum of 0.3 per cent. free alkali respectively, based on a moisture content of 30 per cent. With the difficult marketing position of tung oil, the possibility of blending such local oils with soapstock is being examined.

(c) Expelling Investigations

When the expelling plant commenced, a considerable amount of investigational work was required to reach the required standards of less than 8 per cent. oil content, and 42–45 per cent. protein content. In this work some 200 samples of cake and meal were analysed. The first samples of cake contained 40–42 per cent. protein and 12–16 per cent. oil. The oil content was clearly too high to result in the expected yield of 14

per cent. neutralized oil as allowed for in the estimates for the process, as only about 12 per cent. crude oil was obtained. Also the requirements of the cattle food industry are not complied with as regards oil content.

An examination of the extraction process was therefore necessary. In similar investigations with tung seed, the moisture content of the meal fed to the expeller was found to be of critical importance. A number of " runs " which varied this factor, and also husk content of the meal, were therefore made. The first impression was that the meal was not being satisfactorily cooked, and it seemed significant that the lowest oil content had been obtained when a second and also extended cooking had been given. Although extended cooking can be given initially, once the press is working and the meal is flowing through, the cooking period is of course fixed. The moisture content of flaked meal (1957 crop) was 6–7 per cent., and it appeared that more moisture would be necessary to help in the breaking down of the cells, particularly as this was with older and therefore rather harder kernels. With tung it has been noted that if seed is carried over to the following season, the expression of the oil is much more difficult.

To improve the cooking process, an extra steam jet was inserted into the top kettle, to assist in releasing the oil. Using this, it was possible to reduce the retained husk content to about 10–15 per cent., and a cake of 8–9 per cent. oil content was obtained, the protein content varying from 41.5 per cent. to 43 per cent. Occasionally protein contents of up to 45 per cent. were obtained. In view of this variation, different samples of bulk stock of seed were analysed and found to contain from 32.8 per cent.–34.3 per cent. protein in the kernel, compared with a sample of Congo seed, which contained 35.1 per cent. It was also significant that using the 1957/58 crop of seed, this was found to cook rather more easily, and cake of 7–8 per cent. oil was obtained, about 10 per cent. of husk being fed in, together with a proportion of previously made cake. This material fed back was powdery cake, separated from the properly formed cake from the press. This powder arises from the fact that incomplete cooking of the meal prevents uniform caking, and it was found that such powder contained approximately 3 per cent. more oil (11–13 per cent.), than did the well-pressed cake coming from the mill at the same time, which contained 8–9 per cent. oil. This explained one difficulty of producing a uniformly low " oil content " cake, and so the bulk production of cake was sieved before shipment.

Although production of cake to meet buyers requirements was maintained, it was desirable, from the aspect of oil production, to reduce the oil content of the cake still further. The makers of the press were consulted, and it transpired that they themselves had now appreciably modified their standard press, in view of their own experiments with cotton seed. They therefore supplied some of these modifications which could be fitted to the existing machine—and some improvement was effected to give cakes of 6–7 per cent. oil content.

The full composition of typical cotton seed cake is given below, and local groundnut cake is quoted for comparison.

	Groundnut Cake	*Cotton Seed Cake*
Moisture	6.2	4–5
Oil	9.2	8–9
Protein	42–43	42–44
Fibre	3.5	8–10
Digestible Carbohydrates..	34.2	26–28
Ash	4.2	6.9
,, Containing Calcium	0.20	0.16
,, ,, Magnesium	0.34	0.67
,, ,, Potassium	0.72	1.34
,, ,, Phosphate (P_2O_5)	1.36	2.6

(d) Cotton Seed Oil

The factory was supplied with the procedure for neutralization and decolorization of the crude cotton seed oil, the acidity of which varied from 2.5 per cent.–5 per cent. With the early neutralization a very pale oil (Lovibond 30Y. 3R), was obtained. But as the efficiency of the expressing process increased, a darker crude oil was obtained. However, it was possible to maintain the standard of 50Y and 5R, required by the buyers, although this is about the limit that can readily be obtained by caustic soda process alone—without a bleaching plant.

Apart from the colour, the other characteristics of the oil were as follows, the requirements of B.S.S. 655 for cotton seed oil being quoted for comparison.

	B.S.S. 655/1950— amended	*N.O.I.L. Sample*
Specific Gravity at 15°C.	0.921–0.924	0.924
Refractive Index	1.472–1.473	1.473
Iodine Value	103–113	107.4
Saponification Value	not less than 192	197.1
Acidity	not more than 0.1%	0.08%
Unsaponifiable Matter	,, ,, ,, 1.2%	0.24%
Volatile Matter	— —	0.10%

(e) Oil Colour

Following the production of the low oil content cake, although the colour of the oil at the time of despatch was satisfactory, reports from the Salisbury buyers indicated that on receipt the oil was of a rather darker colour up to 7R, compared with the specified maximum of 5R. Checks of each Tintometer showed no instrumental discrepancies and it was agreed that the oil was definitely darkening during transit. This was found to be due to incomplete removal of the soap stock from the oil, the colouring matter returning to the oil. This trace was very finely dispersed, and various filtering trials were unsuccessful. Extra oil storage was built, which allows of 4–5 days settling before the oil is drummed, and the difficulty is now largely overcome.

(f) Cake Quality

Consistency in composition has been maintained, and buyers have generally expressed satisfaction. One or two queries regarding individual consignments have been examined, and though small divergencies have been noted, the complaints appeared to be commercial gambits, and the value and essential need for laboratory reports in such instances, before any settlement is reached, cannot be over-emphasized, for an appreciable amount of money may be involved.

In the latter part of the period under review, the demands for day-to-day laboratory assistance have decreased, as the N.O.I.L. laboratory came into action, and a laboratory assistant, who had been trained in the basic examination of oil and cake, commenced duties there. Full cake composition is however not yet carried out there.

COTTON PEST RESEARCH (C.D.W. SCHEME R817)

Introduction

The basic investigations into the biology and control of the cotton bollworms, together with toxicological work, continue to be carried out at the Gatooma Research Station, while investigations into the biology of cotton stainers continue at the Makanga Experiment Station. Insecticide trials, together with associated biological studies based on the work at Gatooma have been extended to the Chitala Experiment Station, Central Province, Nyasaland, and to the Sabi Valley Experiment Station, Southern Rhodesia.

Investigations at the Gatooma Research Station

BIOLOGICAL INVESTIGATIONS

Detailed observations on the behaviour and natural mortality of the various stages in the life cycle of *Diparopsis castanea* Hmps. have been made under both laboratory and field conditions. Knowledge of certain aspects of the biology of *Diparopsis* is considered to be of paramount importance for the development of control measures.

EGG MORTALITY

The proportion of eggs lost remained high throughout the season, reaching 80-100 per cent. over certain periods. Towards the end of the season continuous observations were made on 397 eggs to determine the causes of egg loss. Ants accounted for the loss of 34 per cent. of these eggs. The ants, *Pheidole megacephala* F., were observed removing eggs and carrying them off the plants. 35 per cent. of the eggs were lost through no obvious cause, although heavy losses following rain suggest that loss of adhesion is influenced by the wetting of eggs. Losses occurred throughout the day and night with a rather greater loss between 10.00 hours and 24.00 hours. The remainder of the eggs, totalling 31 per cent., hatched successfully.

BEHAVIOUR AND NATURAL MORTALITY OF 1ST INSTAR LARVAE FROM THE TIME OF HATCHING TO PENETRATION OF THE PLANT

The 1st instar larvae will penetrate buds, flowers and green bolls of all ages, and in their absence early in the season will penetrate the terminal growing point of the plant. Observations in the field with the incubation period ranging from 6–13 days showed that the time of hatching remained between 04.00 hours and 08.00 hours. The time taken to reach the site of penetration ranged from 15-310 minutes (Mean, 115 minutes) and a further 3–240 minutes (Mean, 126 minutes) was taken to penetrate the plant. Mortality over this period was 30 per cent. most of which was accounted for by larvae ceasing movement and dying without an apparent cause. Dispersal by means of dropping on a thread was more common amongst those larvae which ultimately died. Frequently, larvae hanging on a thread were blown away by the wind. The period of wandering by larvae which ultimately died, greatly exceeded the period of wandering of larvae which successfully penetrated.

BEHAVIOUR AND NATURAL MORTALITY OF 5TH INSTAR LARVAE ON LEAVING THE PLANT FOR PUPATION (observations based on 37 larvae)

Generally, a larva on leaving the boll moved up to the bracts where it sometimes rested before dropping to the ground. On reaching the ground the larvae tended to move away from the plant to find a suitable point of entry into the soil—usually a crack or loose soil. Pupation sites were fairly evenly distributed between the rows, with the depth of pupation from $\frac{1}{2}$–6 inches. Approximately 88 per cent. of the larvae left the plant between 19.00–01.00 hours. No larvae were observed to pupate between 04.00–18.00 hours. The mean total period on the plant (movement and resting period) was 21 minutes (Range 0–150 mins.), while wandering on the ground occupied 26 minutes (Range 0–115 mins.) and the period of penetration was 34 minutes (Range 5–125 mins.). During these periods total mortality was as low as 8.1 per cent. of which ants accounted for 66 per cent.

BEHAVIOUR AND NATURAL MORTALITY OF DIPAROPSIS FROM THE FIRST PENETRATION OF A 1ST INSTAR LARVA TO EMERGENCE FROM THE SOIL AS AN ADULT MOTH

By continuous observations, the fate of 90 eggs, which hatched between 12th and 15th March, was recorded.

During the second 24 hour period following bud penetration, all larvae except one were observed constructing a cell-like structure at the point of penetration. This cell, which often joined the inside surface of the bract to the bud, was composed of

silken threads, frass and other debris, sometimes strengthened by a secretion. The purpose of the cell is not known, although it may protect the larva during the first moult and early development. The larvae which did not construct a cell penetrated a bud which flowered soon after penetration. 30 per cent. of larvae in buds shed regained the plant without being attacked by ants on the ground. In some cases, the larva joined the pedicel of the bud to the sympodial stem with webbing; on being shed the bud remained hanging to the plant, and this facilitated survival.

The length of the larval stage averaged 38 days (March–April) but owing to the high degree of pupal mortality, the pupal period was not measured in this experiment. However, from other experiments, a pupal period (short-term pupae) of 21 days and an egg incubation period of 9 days would give a total life cycle of approximately 10 weeks. This period is undoubtedly influenced by climatic factors, but it is unlikely that more than two generations of *Diparopsis* are produced during the main period of crop development. This emphasizes the importance of achieving good control of the initial invasion of the cotton crops by *Diparopsis* originating from overwintering pupae.

Approximately 60 per cent. of the larvae were exposed to a greater or less degree and then re-entered the fruiting point; the mean period of exposure being 403 minutes. Most larvae transfer from one fruiting point to another, taking a mean period of 41 minutes. The majority of transfers occur from the 16th to the 34th 24 hour period following bud penetration. All main movements of larvae occurred at night.

The mortality from the time of larval penetration of the plant to moth emergence averaged 98 per cent., ants accounting for at least 69 per cent. of the total population observed. The pentatomids *Macrorrhaphis* sp. and *Agonoscelis versicolor* Fabr. were also recorded as predators.

Four moths were observed emerging between 19.00–22.00 hours. On emergence the moths move actively over the surface of the ground before resting to dry their wings. When the wings were fully expanded the moths flew to a nearby plant and rested; the male only resting for a short period before flying away. The females continued to rest and with the appearance of a male, mating invariably took place on the under side of a leaf, after which the sexes separated and flew away.

PUPATION EXPERIMENTS

(*a*) *Larvae collected from ratoon cotton and set in the pupation gardens*

The majority of larvae collected from ratoon cotton in October/November produced short-term pupae which gave rise to moths over a period of some 15 weeks. When examined in March, 1.3 per cent. of the pupae were alive (long-term pupae ?) but may have emerged before the end of the season. This data demonstrates that ratooning cotton can allow an early build-up of *Diparopsis*.

(*b*) *Proportion of Diparopsis larvae forming overwintering pupae and the subsequent moth emergence under pupation garden conditions*

As in previous seasons the proportion of long-term pupae being produced increased from nil per cent. in February to 100 per cent. by the end of April. Moth emergence from overwintering pupae extended from October to March with a distinct peak in emergence during late December-January. A small proportion had not given rise to moths by April and may carry over to the second season following pupation, although there was the possibility of the moths emerging later the same season.

(*c*) *Emergence from overwintering pupae under field conditions*

The field cages were set in a 1957/58 cotton field which had been sprayed with Endrin. The initial pupal population was much lower than in the previous season;

however, mortality was only 52 per cent. and the number of moths emerging was approximately 3,600 per acre. Moth emergence period extended from October to March, but the pattern was different to that obtained under pupation garden conditions. The causes of the different moth emergence patterns have not yet been determined. 2.7 per cent. of the pupae were alive at the end of the season and will presumably give rise to moths in the 1959/60 season.

(*d*) *Effect of temperature on moth emergence from overwintering pupae*

Overwintering pupae were set at 75°F, 85°F, 95°F and 105°F. A temperature of 105°F proved lethal to pupae, while at 95°F moths had difficulty in emerging from the pupal case. At both 75°F and 85°F a monomodal moth emergence pattern extending from the 4th or 5th week following the date of the start of incubation occurred. In both cases an extended period of emergence until about the 20th week was noted.

(*e*) *Effect of depth of pupation on moth emergence*

Overwintering pupae collected in the field during August–September were set in the pupation garden at depths of $\frac{1}{2}$ inch, 1 inch, 2 inches, 3 inches, 4 inches, 6 inches and 8 inches. The length of emergence period—approximately 16 weeks—was hardly affected by depth, although the date on which moth emergence commenced was considerably modified. Pupae set at shallower depths gave rise to a later emergence. At these shallow depths, temperatures at certain times are sufficiently high to inhibit pupal development, although other factors, e.g. rainfall, may influence moth emergence. As the majority of pupae set at 6–8 inches have emerged by the end of December, it is possible that with certain soils, inversion of the top 8 inches will modify the emergence period.

The Control of Diparopsis and other Pests of Cotton

CHEMICAL CONTROL

The toxicity of various insecticides to insect pests of cotton is being investigated in the laboratory by bio-assay techniques. However, the number of experiments has been restricted by the difficulty in rearing the insects in sufficiently large numbers to carry out statistically valid assays.

Diparopsis and *Heliothis* cultures are now being maintained.

TOXICITY TESTS

Diparopsis eggs laid on muslin, incubated at 75°F at which temperature they hatch after 6 days, have been dipped into various concentrations of insecticides, when 5 days old. No insecticide tested has prevented the development of the egg, but as the 1st instar larva eats its way out of the egg, it can be killed before it leaves the egg shell. The concentration at which 50 per cent. of the eggs hatch in tests so far carried out is recorded in Table I.

TABLE I

Provisional LD50 for insecticides tested against Diparopsis eggs

Insecticide	% *concentration*
Sevin	0.002—0.004
Endrin	0.008—0.03
B.H.C.	0.014
Rogor	0.023
Aldrin	0.032
Dieldrin	0.051
Malathion	0.145
D.D.T.	0.17—0.24

Individual buds have been sprayed to " run off " and individually infested with a single *Diparopsis* egg. The toxicity of the insecticide is evaluated by the number of 1st instar larvae which penetrate the bud. Initial results with this technique indicate that the relative toxicity is comparable with the egg dipping technique.

Results to date indicate that Sevin is very toxic to the 1st instar larvae of *Diparopsis*.

Toxicity tests with *Heliothis* have been commenced, and indicate that D.D.T. is more toxic than Sevin.

PERSISTENCE OF INSECTICIDES

Single rows were sprayed to " run off " and the persistence assessed by the percentage penetration of sample buds individually infested with *Diparopsis* eggs. All the insecticides persisted fairly well until it rained. The D.D.T. emulsion was the most persistent as shown in Table II.

TABLE II

Percentage penetration of buds at intervals following spray application—corrected for control mortality on unsprayed buds

Insecticide	% *concentration of spray*	*Sample collected—days following spray*				
		0	2	4	7	10
Endrin emulsion	0.50	0	0	16.7	52.5	23.3
,, ,, ...	0.25	0	16.7	30.8	90.0	85.0
Sevin wettable powder	1.00	0	0	0	7.5	38.6
,, ,, ,, ...	0.50	0	0	0	15.0	46.4
D.D.T. emulsion	1.00	0	0	0	15.8	7.8
Progressive rainfall total ..	—	0″	0″	0″	0.77″	0.99″

SPRAY COVERAGE

Investigations into coverage of cotton plants with insecticide sprays were commenced in collaboration with the Colonial Pesticides Research Unit, Arusha, Tanganyika.

FIELD TRIALS

FIELD TRIAL I—FARM SCALE INSECTICIDE TRIAL

This was continued with four sprayed and four unsprayed plots each of three acres, arranged in pairs; each pair situated on a farm in the Gatooma district. One pair of plots followed pigeon pea and the other plots, except one (following wheat), followed maize; all plots received fertilizer applications. Plots 6, 8 and 12 received 8 applications of Endrin at the rate of $\frac{1}{4}$ lb. active ingredient in 10 galls. of water per acre at weekly intervals from first buds using a Leo-Colibri No. 9 pressure-retaining knapsack sprayer giving a constant pressure of 50 lb. per sq. in. (see Table III). Plot 10 received only 5 applications at fortnightly intervals. The nozzles were changed from D2 Hollow Cone Discs to Conejet Y6 tips as a result of spray coverage tests. The sprayed plots were situated at least one mile from the unsprayed plots, and from each plot records of plant growth and insect populations were taken at fortnightly intervals from four sampling areas.

The cotton variety was Albar 637 as the lint quality of American Upland G52/36 used previously was not very satisfactory. The 1958/59 season was favourable to plant development in the Gatooma district and there was a significant increase in

yield due to spraying. Significant differences between farms was due to the early planting date at the Gatooma Research Station (a month earlier than other farms) and the fortnightly spraying on another farm.

The *Diparopsis* population was generally higher than the previous season, but despite this the plants were able to set a reasonably good crop during the early part of the flowering period. The live overwintering population at the end of the season was higher than in 1958, although considerable mortality had occurred on most plots.

A heavy *Heliothis* attack occurred on the sprayed plots during the peak flowering period, and was not effectively controlled by the Endrin spraying. *Earias* and *Dysdercus* populations were again low.

Maximum shedding coincided with the *Heliothis* attack, and rather more of the sheds on the sprayed plots were damaged by bollworm than on the unsprayed. As Albar 637 is resistant to bacterial blight, damage due to this disease was negligible.

Tagging of white flowers daily on plots 11 and 12 indicated that 22.4 per cent. of the flowers tagged developed into clean bolls on the sprayed compared with only 8.6 per cent. on the unsprayed plot.

A cotton boll analysis on each plot revealed a mean boll weight of approximately 4 grams. The number of bolls which opened per plant was below 13 and of these generally less than half remained undamaged.

FIELD TRIAL II

The insecticides Endrin, Sevin and D.D.T. were applied for eight applications during a period of nine weeks as indicated in Table IV in a randomized block experiment with five replications.

The yield of the D.D.T. treatment was significantly higher than the yields of the three Endrin treatments and the two Sevin wettable powder treatments. The lower yield from a Sevin treatment was significantly less than any of the three Endrin treatments. There were no significant differences within the different Endrin or Sevin treatments. The entomological data suggests that these yield differences were caused by differences in the efficiency of the sprays in controlling *Heliothis* attack, which was the main cause of loss of yield. It is also apparent (Table IV) that Sevin gives a better control of *Diparopsis* than either Endrin or D.D.T., the last being least efficient in control of this pest.

The data of the cotton boll analysis indicated that increased coverage given by using a boom with 6 nozzles per row at the end of the season did not significantly increase the number of bolls, or affect the proportion which were clean.

FIELD TRIAL III (see Table V)

As the Endrin in the Field Trials I and II was not controlling *Heliothis*, some cotton which had already received 7 applications of Endrin, was sprayed to "run off" to determine whether complete control could be obtained. *Heliothis* larval counts at intervals before and after spraying showed that even when heavily applied, Endrin did not give complete control. Increasing the number of applications from seven to twelve, even at low volume, resulted in a substantial increase in yield (see Tables III and V).

OTHER FIELD TRIALS

D.D.T., D.D.T. + B.H.C. and Sevin dusts were applied by means of an airblast knapsack unit, to cotton infested with *Heliothis*. Applications of 15–20 lb. of 5 per cent. D.D.T. or 5 per cent. Sevin dust resulted in approximately 80 per cent. reduction in the *Heliothis* larval population.

Endrin, Dieldrin, Sevin and D.D.T. were applied at various rates to cotton infested with *Dysdercus*. Owing to stainer movement between plots and from outside the trial, none of the treatments completely cleared the plants of stainers. Sevin and D.D.T. applied at 1 lb. active ingredient per acre or Endrin and Dieldrin at $\frac{1}{2}$ lb. a.i.p.a. gave better control than at lower rates of application.

CULTURAL CONTROL

Observations on the behaviour of 5th instar *Diparopsis* larvae on pupation indicated that it might be possible to localize pupation sites by trenching between rows. 3 furrows 5–6 inches deep were dug between 4 rows of cotton, and observations made on 38 larvae. Only 63.2 per cent. of the larvae penetrated within 6 inches of the centre of the trench; the other larvae generally penetrated cracks or patches of loose soil on the sides of the trenches.

TABLE III

Farm Scale Insecticide Trial—Entomological and Agronomic Data. Trial I

Zone	Plot and Treatment	Yield lb. S.C. per acre	Per cent. damaged	Per cent. Stand	*Diparopsis Populations*				*Heliothis*		*Earias*	*No. sheds/ plant*		*Per cent. sheds due BW.*	
					Mean No. Eggs per plant	Mean No. larvae per plant	No. pupae per sq. ydra	Carry-over pupae per sq. yard	Mean No. Eggs per plant	Mean No. larvae per plant	Mean No. larvae per plant	Buds	Bolls	Buds	Bolls
I	12 S	1,158	11.1	86.7	2.51	3.44	2.25	1.50	4.93	5.94	0.31	24.2	28.1	92.1	73.7
	11US	809	14.9	72.8	2.63	3.44	2.50	1.05	1.01	2.25	0.88	14.1	23.8	74.9	60.4
II	10 S*	565	20.9	98.7	2.84	1.94	1.85	1.00	2.18	2.56	0.19	11.6	11.3	75.0	65.5
	8 S	1,044	4.7	88.7	1.14	1.13	1.70	0.10	3.25	3.31	—	11.2	16.5	74.8	63.5
	6 S	949	5.4	109.7	1.01	1.13	2.00	1.35	1.63	1.56	0.06	2.6	10.2	76.1	48.2
	9US	466	14.5	117.4	1.83	2.13	1.05	0.40	0.55	1.19	0.56	7.4	11.8	86.9	65.4
	7US	653	3.8	85.2	1.16	0.81	0.55	0.15	0.38	0.56	0.31	6.2	13.1	57.8	34.5
	5US X	531	8.8	109.6	0.95	1.50	0.90	0.25	0.95	0.44	0.75	5.3	9.4	70.6	58.7

I = Gatooma Research Station
II = 6–20 miles from Gatooma
S = Sprayed.
US = Unsprayed.
BW = Bollworm.

*= received only 5 fortnightly applications of insecticide instead of 8 weekly applications.

X = plots 1–4 were discarded.

1 = L.S.D. (P = 0.05) between treatments = 82.3 lb.

TABLE IV

Yield and Entomological Data of Trial II

Treatment *	Yield lb. S.C. per acre	Diparopsis Population				Heliothis Population	
		Mean No. Eggs per plant	Mean No. Larvae per plant	Mean No. pupae per sq. yard	Mean No. live pupae per sq. yard	Mean No. Eggs per plant	Mean No. Larvae per plant
1. Endrin ¼ lb. in 10 gallons water/acre (applied with a knapsack sprayer)	1,357	1.56	1.70	3.4	2.6	4.56	5.40
2. Endrin ¼ lb. in 10 gallons water/acre	1,395	1.88	1.70	3.8	1.8	3.68	4.95
3. Endrin ½ lb. in 10 gallons water/acre	1,488	3.56	1.05	5.2	3.8	6.68	4.60
4. Sevin ½ lb. in 10 gallons water/acre	1,108	1.48	0.80	1.8	1.6	3.90	6.10
5. Sevin 1 lb. in 10 gallons water/acre	1,023	0.96	0.65	1.6	0.8	3.74	7.60
6. D.D.T. 1 lb. in 10 gallons water/acre	1,822	1.44	3.20	7.2	5.4	3.76	2.55
Least Significant Difference (P=0.05)	295	0.61	0.72	1.79	1.62	1.67	2.00

* Treatments 2–6 were applied with a boom fitted with drop arms. For the first two applications, the boom was operated by a power-operated "Spraymobile". Later knapsack sprayers were fitted to various types of "hand boom".

TABLE V

Yield Data of Field Trial III

Treatments	Yield S.C. lb. per acre	Per cent. damaged
1. 7 weekly applications ¼lb. Endrin in 10 gallons water/acre + 5 weekly applications ¼lb. Endrin in 10 gallons water/acre ..	1,835*	3.8
2. ,, ,, ,, ,, ,, ,, ,, ,, ,, +5 ,, ,, 0.25% Endrin at 400 gallons per acre.	1,927	1.3
3. ,, ,, ,, ,, ,, ,, ,, ,, ,, +5 ,, ,, 0.025% Endrin at 400 gallons per acre.	1,852	2.7

* Compare with plot 12 of Field Trial I which received 8 instead of 12 applications. Table III.

INVESTIGATIONS ON DYSDERCUS SPP.

Unfortunately *Dysdercus* numbers this season were again very small due basically to the adverse climatic conditions that directly and indirectly inhibited breeding and caused high mortality. The result was that experiments in chemical control could not demonstrate any large reduction in insect population. Later in the season, but too late to cause any considerable damage, the *Dysdercus* population greatly increased (June and July).

The rainfall was late and little rain fell until the end of December, 1958, in most areas this season. At Makanga Farm only 3.85 inches fell during this month (compared with last season's 6.51 inches and 8.01 inches in 1956/57). The rainfall pattern was such that relatively heavy showers occurred at comparatively long intervals, the intervening periods being hot and dry. These conditions were ideal for the crop and in spite of the late start to the rains, the cotton crop was an extremely good one.

Routine records were continued throughout the season sampling *Dysdercus* populations on both their alternate hosts and on cotton as a basis for a comparative study over the years, and surveys of alternate host populations were carried out in two of the main cotton-growing areas.

LONG-TERM EXPERIMENT ON THE EFFECT ON DYSDERCUS OF CUTTING DOWN ITS MAJOR PRE-RAINS ALTERNATE HOST, THE TREE STERCULIA AFRICANA

In this experimental area of 50,000 acres, 40 plots of one-tenth acre each were used for recording yields and *Dysdercus* populations. The plots were situated in concentric circles with the centre at Sorgin, 8 plots on each circle roughly equidistant from one another. The inner circle of 8 plots was within ½ mile from the centre at Sorgin; the next 8 plots 1½–2 miles from the centre; the third 3–3½ miles and the fourth 4½ miles from the centre. The fifth series of 8 plots could not be arranged equidistant on a circle owing to topographical difficulties, but were placed at a distance of about 6 miles (i.e. one mile outside the limit of the experimental area) to the north and west.

Results of the weekly sampling of each plot over the period March and April indicated slightly higher numbers of *Dysdercus* on the perimeter plots both inside and outside the experimental area, but that later in the season the *Dysdercus* population was higher on the plots near the centre. This was thought to be due chiefly to inter-cotton-field movements, adults moving from the outer to the inner cotton fields (see Table VI).

TABLE VI

Summary of Dysdercus Population record, Sorgin Experiment

Number of Adults per acre

Month	*Area A*	*Area B*	*Area C*	*Area D*	*Area E*
March	124	124	247	393	270
April	354	394	293	712	675
May	644	436	294	433	608
June	1,012	675	548	554	754
Fifth-instar Nymphs per acre					
March	34	0	0	0	259
April	225	101	135	270	338
May	1,117	304	169	158	439
June	3,701	1,159	338	450	2,755

	Approximate Numbers of Young Nymphs per acre				
March	300	0	0	0	700
April	700	500	400	400	1,100
May	2,000	1,000	1,000	1,000	3,500
June	7,000	1,000	1,000	1,000	5,000

Area A was the closest to the centre, Area D on the perimeter of the experimental area and Area E outside the experimental area.

The yield per acre was high, as was expected this season: twenty-four of the forty plots yielded well over 1,000 pounds seed cotton to the acre, and even the lowest yielding plot (which had not been weeded) gave 510 pounds to the acre (see Table VII). The variation in yields was considerable but was due largely to edaphic and cultural factors, and insect pests were of comparatively minor importance.

The percentage Grade II cotton from the areas was higher than the average for the Lower River but this is accounted for by the fact that these plots were closely supervised and all the Grade II cotton was picked (normally all the end of season cotton is not picked in African gardens). The cotton was also graded more carefully.

The variation in amount of Grade II from the different areas was due to some extent to differing bollworm populations and other factors, but there is some correlation with stainers. Area B, for example, with the lowest amount of Grade II cotton, had only about half the *Dysdercus* population of Area D (with the highest amount of Grade II) during March and April, the critical months for staining of lint. This, however, may be no more than a coincidence and *Dysdercus* numbers were altogether too small to give results that mean much. This experiment is being continued.

TABLE VII

Yields per Acre from the Areas of the Sorgin Experiment

*Area**	*Grade I*	*Grade II*	*Total*	*Per cent. Grade II*
A	729	156	885	17.6
B	995	131	1,126	11.6
C	890	171	1,073	15.9
D	1,249	381	1,630	23.4
E	1,105	237	1,342	17.7

*Each area represents 8 plots or a total of four fifths of an acre.

DESTRUCTION OF ALTERNATE HOSTS

Experiments were made using various arboricides for the destruction of *Sterculia africana*, the most important pre-cotton breeding host in the main cotton growing areas. Results to date indicate that no quicker control of mature trees can be obtained by using " safe " chemicals (those not a hazard to man or domestic animals) than is found by simply ring-barking a tree at about breast-height and to a depth of about $1\frac{1}{2}$ inches.

It was thought at first that ring-barking had little effect on the tree but this conclusion was premature. Although no effect was apparent in the first year or sometimes for two seasons, and the tree may flower or fruit in the normal manner, in a matter of between two–three years all the trees experimentally ring-barked were virtually dead, the trunk becoming dry and fibrous and riddled with numerous wood-boring and xylophagous insects.

It would appear that it is only a matter of time before the final decay of a tree of this species after it has been ring-barked.

CHEMICAL CONTROL OF DYSDERCUS ON ALTERNATE HOSTS

In order to gain results from this type of experiment heavily infested trees are required together with the rapid breeding of the *Dysdercus* population. This season the climatic conditions were such that not only was it impossible to find trees with adequately high infestations, but very heavy natural mortality in breeding populations was encountered on both treated and untreated trees, and populations on all trees selected for the experiment virtually died out. No significant results could be obtained.

BIOTIC CONTROL OF DYSDERCUS

As last season there were encouraging indications but little further can be said. No significant results could be obtained due to the low numbers of the host insects.

No difficulty was encountered in breeding considerable numbers of the predator (*Phonoctonus nigrofasciatus*) since this was fed largely on *Odontopus* spp. the climatic factors did not have the same adverse effect on these insects as they did on *Dysdercus*.

Natural populations of *P. nigrofasciatus* in the field showed a normal increase (compared with previous years) or an accelerated increase in population when in some cases they outnumbered *Dysdercus* on particular trees.

Natural control of *Dysdercus* due almost entirely to predator control occurred in a number of instances when a control was established on certain observed trees within from one month to six weeks in December–January.

ANALYSIS OF FRUITING-POINTS

In order to obtain some better knowledge of the loss in yield due to damage to fruiting-points and shedding, the plants of 10 plant holes (a mean of 24 plants over the period) were uprooted at intervals from a plot on Makanga Farm. The state of all the fruiting points at the time of uprooting was recorded together with the number of fruiting-points left after shedding. Most of the damage to fruiting-points recorded on the plant was caused by Red Bollworm, (*Diparopsis castanea*) and Blackarm, (*Xanthomonas malvacearum*).

Shed fruiting-point collections from this plot showed that only about one-third of the total sheds could be attributed to direct insect damage and there was no reason to suppose that there was any indirect insect attack that could have caused the others.

SHED FRUITING-POINTS

The mean percentage number of shed bolls throughout the season having direct insect damage was 43 per cent. of the total bolls shed, a mean of 57 per cent. being shed due to unknown causes and not attributed to direct insect damage. A proportion of these showed signs of having been attacked by Blackarm at one stage or another, but the amount of shedding of bolls due apparently to physiological factors was considerable and comprised at least 30 per cent. of the mean total from March to July.

Of the total buds shed, 48 per cent. were found to suffer from direct insect damage (almost entirely bollworms), and of the total flowers shed 40 per cent. were found to have insect damage (again largely by bollworms).

These figures were calculated from sample rows in 12 African gardens, a collection being made each week of the sheds between two rows for 10 yards in each garden.

Investigations in other Areas of the Federation

CHITALA EXPERIMENT STATION, CENTRAL PROVINCE, NYASALAND

Observations on cotton insect pests were commenced at Chitala Experiment Station with the introduction of an insecticide trial. The aim of the trial was to

assess the effect of the insecticide Endrin in controlling cotton insect pests in the Lakeshore area, and to determine whether there were any differences in response between raingrown cotton at Chitala and at Gatooma.

The randomized block experiment was sited in two areas each of an acre, the previous crop in one area being maize and in the other area grass. Both areas were planted with Albar 637 on 18th December, 1958, and fertilized. The cotton was planted on the ridges 3 feet apart and 2 feet between plant holes, with 3 plants per plant hole. The sprayed plots received 8 weekly applications of Endrin at $\frac{1}{4}$ lb. a.i. in 10 gallons of water per acre, commencing just after first buds had appeared. Insect and plant development records were taken weekly (see Table VIII).

A substantial increase in yield was obtained as a result of spraying, and the difference in yield between the two areas was also significant. Comparing the mean insect pest population per plant for an equal sampling period, it would appear that the level of *Diparopsis* is rather higher at Chitala, although a greater degree of control was obtained with spraying. There was considerable pupal mortality.

Heliothis egg population were also quite high, but in contrast to Gatooma reasonable control was achieved with Endrin. *Earias* appeared only in small numbers and *Dysdercus* population only built up after spraying had ceased.

Rather more than twice as much shedding of buds occurred on the unsprayed plots, and of these the majority were damaged. Tagged flowers indicated that about 18 per cent. produced clean open bolls on the sprayed plots and only 4 per cent. on the unsprayed.

TOLEZA FARM, BALAKA, NYASALAND

Observations on cotton at the Agricultural Production and Marketing Board Farm were carried out under the direction of the Government Entomologist. The mean yield of the cotton (Albar 637), sprayed with Endrin, was 1,464 lb. seed cotton per acre and 1,029 lb. seed cotton per acre on the unsprayed—a significant increase due to spraying. *Diparopsis* eggs were recorded in fewer numbers during March when *Heliothis* were recorded. *Heliothis* generally occurred in fewer numbers than the previous season.

SABI VALLEY, SOUTHERN RHODESIA

Cotton is a very important crop in irrigation schemes in the Sabi Valley, where the wild host plants of *Diparopsis* and *Dysdercus* occur in large numbers. With the application of insecticides, yields of over 2,000 lb. seed cotton per acre are being obtained on a commercial scale. Observations on the insect pests—*Diparopsis*, *Heliothis*, *Platyedra*, *Earias* and *Dysdercus*—are being carried out to determine their importance on cotton and the alternate host plants. Although never previously recorded in Southern Rhodesia, *Platyedra gossypiella* Saund. was discovered in the Sabi on cotton and *Hibiscus dongolensis* in May, 1959. It was recorded in Nyasaland in 1939, but has not been recorded since 1943.

Summary

Considerable data on the life history of *Diparopsis* has been obtained, which will be of great value for the development of control measures.

Egg mortality has been shown to be extremely high at certain times. Under field conditions the incubation period is 6–13 days although the time of hatching remained between 04.00–08.00 hours.

The 1st instar larvae wander for a sufficiently long period before penetrating the plant to be exposed to insecticide deposits for a reasonable period. During development larvae have been shown to construct a protective cell at the site of penetration; exhibit " re-entry " movement, and transfer to fresh food; and when fully developed to drop from the plant and move away to pupate.

Mortality, caused by ants, including *Pheidole megacephala* F. was of considerable importance at all stages in the life cycle.

Pupation experiments have shown the importance of early build-up of *Diparopsis* infestations if cotton is rattooned. Overwintering pupae formed in increasing numbers towards the end of the season give rise to moths from October to March the following season, with a small proportion carrying over to a further season. Pupal development at 75–85°F gives rise to moths over a period of twenty weeks. Depth of pupation affects the date at which moth emergence commences without affecting the length of the emergence period.

This year's insecticide trials confirmed that substantial increases in yield can be obtained by spraying Endrin regularly with a minimum number of 8 applications, provided that there is a high potential yield. However, infestations of *Heliothis* were more effectively controlled by D.D.T. Sevin was used on a laboratory and field scale and shown to be very effective in controlling *Diparopsis*.

Cotton yields were extremely good in the Lower River, despite late planting rains. Cotton stainer populations built up too late in the season to cause any considerable damage. The *Sterculia* eradication experiment indicated that the stainer population during the critical March–April period was lower in the centre of the area cleared of *Sterculia* trees for the 1958/59 season.

Platyedra gossypiella Saund. was recorded for the first time in Southern Rhodesia on cotton and *Hibiscus dongolensis*.

TABLE VIII

Data for the Insecticide Trial at Chitala Experiment Station

Area[3]	*Treatment*	*Yield lb. S.C. per acre*	*Diparopsis*				*Heliothis*		*Earias*	*Sheds/plant*		*Per cent. sheds due Bollworm*	
			Mean No.[1] *Eggs per plant*	*Mean No.*[1] *larvae per plant*	*Mean No.*[2] *pupae per sq. yard*	*Mean No.*[2] *live pupae per sq. yard*	*Mean No.*[1] *Eggs per plant*	*Mean No.*[1] *larvae per plant*	*Mean No.*[1] *larvae per plant*	*Buds*	*Bolls*	*Buds*	*Bolls*
I	Sprayed	1,138	2.30	1.30	3.75	0.50	2.80	0.80	—	3.1	23.6	43.2	34.6
	Unsprayed	587	4.40	1.70	5.19	1.56	4.60	1.90	0.20	6.9	28.0	83.1	69.6
II	Sprayed	771	3.80	2.50	2.06	0.37	2.80	1.20	—	5.3	23.2	50.0	33.5
	Unsprayed	202	6.20	3.30	2.81	0.44	4.70	3.40	0.30	12.0	25.9	84.0	78.1
	L.S.D. (P=0.05) ..	207											

[1]=adjusted to same number of samples as at Gatooma for comparison.
[2]=sampled in September, 1959.
[3]=Area I followed maize; Area II followed grass.

ROTATION EXPERIMENTS

1. EFFECT OF MANAGEMENT OF RHODES GRASS ON A MAIZE CROP FOLLOWING PLOUGHING OUT OF THE LEY

On red brown sandy clay loam at Chitedze a $3 \times 3 \times 3$ factorial was laid down on a Rhodes grass ley to test the effects of time and level of nitrogen application and the number of cuts taken per season. The design was not confounded and there were two replications. Treatments were sulphate of ammonia at nil, 200 lb. per acre and 400 lb. per acre applied:

(*a*) before the rains

(*b*) after the first cut in January, and

(*c*) half before the rains, and half in January

One, two or three cuts were also taken per season. These treatments were applied for two seasons, 1955/56 and 1956/57. In the 1957/58 season, the land was ploughed in early February after one cut had been taken, and the late fertilizer applications made. In 1958/59, a test crop of maize was grown. There were no significant differences between the treatments as main effects, but there was a significant increase in the yield of maize where 400 lb. per acre sulphate of ammonia had been applied to the grass just before it had been ploughed. The increase is not nearly as great as that which would have been obtained had the nitrogen been applied directly to the maize. Mean yield was 3,100 per acre grain with a Coef. Varn. of 11.4 per cent. This confirms past experience that there is no residual effect, when the ley is ploughed, from sulphate of ammonia applied to Rhodes grass cut for hay or silage, unless the dressing is a very large one.

2. MAIZE AFTER RHODES GRASS

An experiment to observe residual effect of fertilizer on a five-year-old Rhodes grass experiment (see Report for 1956/57, page 56) with a test crop of maize, was carried out at Bvumbwe. Effect of early and late ploughing was observed.

The treatments were sulphate of ammonia and nitromonocal, each at the following levels: 100, 200 and 300 lb. per acre every three months and 100 lb. per acre every month—applied to the grass. 150 lb. per acre sulphate of ammonia applied throughout to the maize at planting time.

The design was a randomized block with six replications and split for early (18.3.58) and late (18.4.58) ploughing.

Date planted —12.11.58, with Namalenga variety

Date harvested —12.5.59

TABLE I

Yield, Shelled Maize, Bags (× 200 lb.) per acre

Treatment	*Y.P.A.*
Control	13.65
300 lb. S/A every three months	13.93
100 lb. ,, ,, month	14.38
100 lb. ,, ,, three ,, ...	15.93
300 lb. N/A ,, ,, ,, ...	16.03
100 lb. N/A ,, month	16.16
100 lb. N/A ,, ,, ,, ...	16.42
200 lb. S/A ,, ,, ,, ...	16.44
200 lb. N/A ,, ,, ,, ...	16.59
L.S.D. p=0.01	0.37
Early Ploughing	16.05
Late ,, ...	14.97
L.S.D. p=0.01	0.09
Coeff. of Varn. =10.7%	

The best yields were obtained from the medium rate of both sulphate of ammonia and nitromoncal. The plots which received high rates of sulphate of ammonia, and which gave the highest yields of grass, did not produce high yields of maize; this may be explained by the higher amount of organic material resulting in a temporary shortage of nitrogen whilst it was decomposing, or in a greater total removal of nutrients from the pasture (see Chemist's Report). This is further supported by the fact that early ploughing, whilst the ground was still wet and decomposition active, gave significantly higher yields than late ploughing.

The maize received a basic dressing of 150 lb. per acre of sulphate of ammonia six weeks after planting; this appeared to be sufficient to counteract the effect of a ley ploughed in and previously fertilized at 200 lb. per acre every three months.

3. MPHANJE "A" EXPERIMENT, CHITEDZE

This experiment, laid out at Chitedze in 1954 on a rather poor red sandy clay loam, was designed to test the effects of seven methods of opening land from bush fallow on maize, groundnuts or tobacco as the first arable crop, the six blocks being carried through the four-year rotation in all the combinations of two maize, one groundnut and tobacco crop as grown in the main rotation on the station. There were initially five treatments applied during 1955, and two more were applied later in 1956 so that there are two series of rotations observed, one of three course rotation and one of four. In 1958/59, a maize test crop was grown over the whole area prior to the land going down to ley once more. The initial seven treatments were:

(i) open February, 1955, and plant cowpea

(ii) open February, 1955, and plant sweet potato

(iii) open at end of rains, 1955, burying grass

(iv) open October, 1955, burning grass

(v) open after first rains November, 1955, having burned grass

(vi) open March, 1956, turning in what was left after cutting and carrying off the grass

(vii) open after rains, 1956, after cutting and carrying grass as in (vi).

Yields of maize were best where land was broken from fallow during or just after the previous rains, i.e., treatments (iv) and (v) were poor, and that sweet potato took more out of the land than cowpea, which is to be expected. Groundnut yields

showed little difference between treatments, while tobacco yields were best where no catch crop was grown, even though 300 lb. of 6:18:12 mixture and 25 lb. sulphate of ammonia was applied to the tobacco crop in the 1955/56 season only. This was not intended and subsequent crops of tobacco were not fertilized. Response to fertilizer on this soil is large and as a result the first two treatments shown below are not really comparable with the rest, giving yields in the maize test crop significantly greater than all the others.

TABLE II

Productivity of different 3 and 4 rotations (unfertilized) on a poor red-brown sandy clay loam

Variety: Namalenga, Mwitunde and Western Dark-Fired
Yields: lb. per acre grain, shelled nuts and cured leaf

Rotation				Yield of Maize test crop	Total Groundnuts	Total Tobacco	Total Maize	Productivity Index
55	56	57	58					
*T	G	M	M	3654*	867	883	6035	382/–
*T	M	G	M	3109*	1079	722	5909	363/–
G	T	M	M	2225	1374	446	5331	300/—
G	M	T	M	2221	1135	420	5055	287/–
M	G	T	M	2558	818	353	5241	251/–
M	T	G	M	2449	912	400	5255	269/–
	L.S.D.		5%	558				
	G	M	M	2796	955	—	6374	283/–
	G	T	M	2972	1033	461	2972	325/–
	T	G	M	2937	939	391	2937	294/–
	T	M	M	2590	—	333	3974	231/–
	M	T	M	2348	—	352	4794	231/–
	M	G	M	2859	1016	—	4915	249/–
	L.S.D.		5%	881				

Coef. Varn. 16.4%

*This tobacco crop of 1955/56, received 300 lb. per acre 6.18.12 mixture, and 25 lb. per acre sulphate of ammonia. These rotations are not strictly comparable with the rest.

The Productivity Index was obtained by ascribing a value of 1d per lb. for maize, 4d per lb. for groundnuts and 10d per lb. for tobacco, and reducing the total value from the 3 or 4 year rotation, to shillings per acre per annum. It is a purely comparative figure, but shows the value of including a little fertilizer in the rotation, of including groundnuts in an unfertilized rotation, and of not opening the rotation with a maize crop. It appears to make no difference to the final fertility status in what order the crops are placed in the rotation, but it may exhaust the soil more if no groundnut crop is included, and will probably exhaust the soil less if dressings of fertilizer are applied, even though the productivity is increased thereby.

4. ONE-ACRE BLOCKS OF CONTINUOUS MAIZE

These blocks have been established on fertile red-brown sandy clay loam at Chitedze, on grey-brown sandy clay at Tuchila, red sandy loam at Mbawa and grey-brown sandy clay loam at Chitala. The blocks are cultivated under conditions thought to be optimum for the soil and climate, with the object of trying to maintain maize yields under a monocropping system. No block has been going for more than four years, and maize yields are still rising on all blocks.

(*a*) *Chitedze.* In 1958/59, this block received a five tons per acre dressing of F.Y.M. for the first time since the treatment began four years ago. This with a top dressing of 200 lb. per acre sulphate of ammonia, gave 20 bags per acre of Namalenga maize, the highest yield to date.

(*b*) *Tuchila.* This block has been receiving treatment for two years now, 200 lb. per acre of sulphate of ammonia being applied each year. Yields to date are 1957/58, ten bags and 1958/59, 15½ bags.

(*c*) *Mbawa.* For the past three years this block has received five tons per acre F.Y.M., 100 lb. per acre sulphate of ammonia and 200 lb. per acre superphosphate each year. Under this fertilizer regime, yields have steadily increased; 1956/57, ten bags; 1957/58, 12½ bags; and 1958/59, fourteen bags per acre.

(*d*) At Chitala an exhaustion plot of continuous maize unfertilized has been going for some years, and produced a yield in 1957/58 of two bags per acre. From 1958/59, half this plot will receive five tons per acre F.Y.M., and 200 lb. per acre sulphate of ammonia, the other half remaining as an exhaustion plot unfertilized. This year's results were: unfertilized, seven bags per acre; fertilized and manured, ten bags per acre. It is likely that the standard of cultivation was considerably improved this last season.

5. EXTRACT FROM REPORT OF THE AGRICULTURAL CHEMIST, BVUMBWE

At Bvumbwe, maize grown on the site of the pasture fertilizer experiment described in previous years, gave variable yields. Generally, the lowest yields were on those plots where high applications of nitrogen had been made, and high yields of grass been obtained. This was most probably due to the high capacity for nitrogen fixation of the residual organic matter in the soils, the greater amounts being in those plots where vigorous grass growth had occurred. The small amount of nitrogen applied to the maize was therefore largely fixed on such plots. An alternative explanation might have been that on those plots where high yields of grass had been removed, some phosphate depletion had occurred, with consequent effect on the maize. Examination of soils from plots covering the range of N applications, showed, however, that no appreciable difference in soil phosphate had occurred.

GRASSLAND

1. GRASS VARIETY TRIAL

An experiment to evaluate six species or strains of grasses was started in 1956/57 season on red/brown sandy clay loam soil at Chitedze using an alternate mowing and grazing technique with the return of clippings developed by Hudson (1933) in New Zealand and described by D. Brown in Bulletin No. 42. of Commonwealth Bureau Field Crops (page 110).

Grazing and cutting started in January, 1958, and three defoliations took place in each of the rainy seasons 1957/58 and 1958/59 The experiment is laid out as a randomized block with four replications, having the plots split for nitrogen at 400 lb. per acre per annum of sulphate of ammonia versus nil. The fertilized and unfertilized halves of the plots are separately fenced to prevent transference of fertilility from one to the other. The fertilizer was applied in two dressings of 200 lb. each annually after the onset of the rains and after the first cut. Bullocks were used for grazing.

Table I shows that *Panicum coloratum* v. *makarikariensis* and *Setaria sphacelata* produced significantly (P=0.05) more dry matter than the two *Chloris gayana* strains and *Cynodon dactylon*. *Cenchrus ciliaris* was significantly better than the Cynodon.

The application of sulphate of ammonia increased the mean dry matter production by 1.68 tons per acre (P=0.01) over the two-year period. Examination of the figures for dry matter production without nitrogen shows that in the absence of fertilizer, the difference between varieties was more marked. The nitrogen varieties interaction just failed to reach significance.

The percentage protein was increased by the application of nitrogen and in this respect different varieties responded differently.

The management of the experiment produced some problems and over the two-year period it is probable that the interval between cuts was too long during the peak of the growing season so that the heaviest cuts were taken when the grasses had passed their most nutritious stage and the mean protein percentage was brought down. In addition, the layout of the experiment is such that all the grasses have to be sampled simultaneously, and since their period of growth to flower emergence varies greatly, the effect of defoliation may well be different from one species or strain to another. In other words, the grasses cannot readily be managed so that each is cut or grazed at the time most suited to its nature and most likely to encourage its maximum production.

2. RHODES GRASS CARRYING CAPACITY TRIAL

An experiment to test the possibility of maintaining cattle throughout the year on Rhodes grass (*Chloris gayana*) pastures was initiated in 1956/57 at Chitedze on red/brown sandy clay loam soils. The treatments were: A. Rhodes grass, unfertilized, with hay and silage saved for the dry season: B. similar management but with 400 lb. of sulphate of ammonia top dressed per year: and C. Rhodes grass with pigeon pea (*Cajanus cajan*) planted in double rows 9 ft. apart which was intended to give year-round grazing *in situ*. Mpwapwa strain Rhodes grass was established by planting " splits " under a maize cover crop in the 1956/57 season when the pigeon pea was also sown. The layout consisted of nine paddocks, three for each treatment. Those for treatment " A " were of four acres each, and those for treatments " B " and " C " were of two acres each, it being the original intention to carry four animals of equivalent type and size on the three paddocks of each treatment.

The establishment of the pasture was slow and it was not fit for grazing until March, 1958. It was then stocked on an observational basis with four animals in each treatment, but by the first week in July all the cattle had to be removed from the

TABLE I

Combined yields of six cuts taken over two years

Dry matter in tons/acre, and mean protein per centages of dry matter

Grass	With N.		Without N.		Mean		
	Dry Matter	*Protein %*	*Dry Matter*	*Protein %*	*Dry Matter*	*Protein %*	
Setaria sphacelata	5.86	10.5	4.92	8.8	5.39	9.6	L.SD. between dry matter mean yield of varieties P. 0.05=0.59 tons/acre.
Cynodon dactylon	5.76	10.2	3.46	9.5	4.62	9.8	
P. coloratum v. *makarikariensis*	6.12	9.6	4.82	7.6	5.47	8.6	
Chloris gayana (Katambora)	6.16	9.1	3.60	9.3	4.88	9.2	
Chloris gayana (Mpwapwa)	5.48	9.9	3.66	8.5	4.57	9.2	
Cenchrus ciliaris	5.70	9.5	4.56	9.2	5.14	9.3	
Mean	5.85	9.8	4.17	8.8			

L.S.D. between dry matter yield with and without N. P. 0.01=0.84 tons/acre.
Coefficient of Variation 6%

Rhodes grass/pigeon pea paddocks as no further feed was available. The pigeon pea was grazed very hard at this time and its stand reduced to less than 30 per cent. It has not subsequently been possible to re-establish it satisfactorily. Hay and silage produced outside the experiment were fed to the remaining two groups from 3rd July to 3rd December, 1958, the animals remaining on the plots.

On 28th November, 1958, the experiment was started formally with two animals only on the " C " treatment so that the stocking rates were a beast to three acres on treatments " A " and " C ", and a beast to one-and-a-half acres on treatment " B ".

Table II shows the mean monthly liveweight changes per acre and per beast on the respective treatments during the twelve months starting 28th November, 1958.

TABLE II

Mean Liveweight gains in lb.

Treatment	*A*		*B*		*C*	
	Per acre	*Per Beast*	*Per acre*	*Per Beast*	*Per acre*	*Per Beast*
December, 1958	+19.3	+58.0	+35.3	+53.0	+23.0	+69.0
January, 1959	+18.0	+54.0	+40.0	+60.0	+24.6	+74.0
February	— 2.0	— 6.0	+ 2.6	+ 4.0	— 1.6	— 5.0
March	+13.0	+39.0	+18.6	+28.0	+10.3	+31.0
April	+ 0.3	+ 1.0	+26.0	+39.0	+ 8.0	+24.0
May	+10.0	+15.0	+15.0	+15.0	+ 5.6	+17.0
June	+ 6.0	+ 9.0	Nil	Nil	+ 4.3	+13.0
July	—11.2	—17.0	—10.0	—10.0	—10.0	—30.0
August	+ 4.6	+ 7.0	— 3.0	— 3.0	— 3.4	—11.0
September	Nil	Nil	+12.0	+12.0	Nil	Nil
October	— 8.6	—13.0	—39.0	—39.0	+ 3.3	+ 5.0
November	— 1.3	— 2.0	+ 8.0	+ 8.0	— 8.6	—13.0
Net gain	48.1	145	105.5	167	55.5	176

The dry season was a long one, only 1.86 inches of rain falling between the end of March and the end of November. After the hay and silage cuts had been taken it was apparent from the yields of conserved fodder that treatments " A " and " B " were under-stocked. The stocking rates were therefore raised to a beast to one-and-a-half acres, and a beast to one acre respectively, by drafting in additional animals on 1st April. At the onset of the dry season there was four acres of standing hay in two paddocks on the " C " treatments. As the season progressed it was seen that this would not all be consumed before the onset of the next rains, and the stocking rate was increased on this treatment also to a beast to one-and-a-half acres.

The experiment is continuing, but some points of interest emerge from this first year of its operation. The first to note are those related to the experimental management which did not in every case make the most of the fertilizers used or the grass produced. The fertilizer dressings on the " B " treatment were split, half being applied at the start of the rains and half after the grass had been cut for hay or silage. This worked satisfactorily in the silage paddock, but the application after the hay cut was too late in the season to appreciably stimulate aftermath growth. A paddock in treatment " A ", closed for hay at the beginning of December, was fit for cutting in February, usually the wettest month of the year, and could not be cut until March, by which time it was of poor quality. It appears from this that pastures should not be closed for hay before the end of December, and if fertilizer is in limited supply it should all be applied at the time of closure, rather than keeping part of it for an aftermath that may not have enough rainfall to grow.

The silage and hay from " A " and " B " were bulked because it was not possible to make the former separately in trench silos without excessive wastage. Supplementary feeding on these two treatments consisted of 20 lb. of silage per beast per day from 22nd June, 1959, to 3rd August, 1959. This was increased to 30 lb. of silage and 10 lb. of hay from 4th August, 1959, to 1st November, 1959, when the silage was again increased by a further 5 lb. per beast per day.

The liveweight losses per head from July to November incluive, were as follows: treatment " A " 25 lb., treatment " B " 32 lb., and treatment " C " 47 lb. This represented the severest part of the dry season. It was noted that on treatments " A " and " B " the cattle did some grazing every day although there was clearly very little growing grass available. The larger acreage available to the animals on " A " may have accounted for the lower liveweight losses recorded over this period when any fertilizer effects were likely to be negligible on the " B " treatment.

Turning to the other results shown in Table II, the main feature is that the application of nitrogenous fertilizer has doubled the out-put per acre this first year.

The results from treatment " C " are encouraging. This is particularly so since it is impractical to recommend the making of hay or silage to African smallholders who have no machinery or tools suitable for grass cutting on a field scale. Therefore, a reasonable level of output from all-the-year-round grazing of Rhodes grass without cutting, represents a first stage in the evolution of a simple system suitable to their needs. The differences in weight gained per beast over the twelve months, are mainly accounted for by the negligible gain of the animals on treatment " A " during April. No explanation can be offered and no significance should be attached to it unless it is repeated in future seasons.

3. RHODES GRASS CARRYING CAPACITY OBSERVATION

At Tuchila, following a somewhat similar observation reported in 1957/58, a four acre block, of three-year old Rhodes grass ley was taken, and after having been fertilized with 200 lb. per acre of sulphate of ammonia in early November, 1958, was managed in the following way. Four oxen, initially each within a few pounds of 580 lb. liveweight, were grazed behind an electric fence from 29th December, 1958, until 20th March, 1959. On this date 1.1 acres which had not been grazed and had been cut for hay a few days previously, was carted. The electric fence was then removed and the animals had free range over the whole four acres. They remained there until 20th May, 1959, when there was no further feed available to them. During the entire grazing period the average liveweight gain was 136 lb. per animal or 1.06 lb. per animal per day.

The hay yield was 3.2 tons per acre, and assuming that 25 lb. per head per day would suffice for maintenance during the dry season, there was sufficient fodder from the experiment for 80 days rations after grazing was finished. Thus the four acres gave 129 days grazing and 80 days ration of hay to four oxen. This left 156 days of the year unprovided for and a further 1.74 tons of hay per animal were required. This would have been provided by an additional 0.52 acres conserved as hay. In other words, approximately 1.52 acres of Rhodes grass suitably grazed and conserved was required to keep an ox of between 580 and 700 lb. liveweight throughout the year, and to provide a moderate liveweight gain.

The rains in the year under consideration started late and finished early. The previous years results in a more favourable season, led to the tentative conclusion that between 1 and 1.25 acres per beast were needed to keep equivalent animals throughout a year. The more conservative figure from this year's trial would be more suitable as a rough guide.

4. NAPIER GRASS SPACING AND FERTILIZER TRIAL

A single replication of a 3^3 factorial experiment was established in 1957/58 on red/brown sandy clay loam soil at Chitedze, to investigate the nitrogen and phosphate manurial responses of Napier grass (*Pennisetum purpureum*), Cameroons strain, at three different spacings. The manurial treatments were 0, 300 lb. and 600 lb. per acre of sulphate of ammonia per year, and similar levels of single superphosphate. The phosphates were applied in the ridge at planting and in subsequent years, band placed on either side at the onset of the rains. The nitrogenous fertilizers were split to give two equal applications during the growing season.

The spacings were S_0, 3 ft. × 3 ft; S_1, 9 ft. × 3 ft; S_2, 9 ft. × 1 ft. The population per acre was, therefore, similar for S_0 and S_2.

A satisfactory stand was not achieved immediately, but by the start of the 1958/59 season, it was adequate, and this interim report covers that first harvest year. The annual phosphate applications and half the nitrogen dressings, were applied on 5th December, 1958, and the other half of the nitrogen on 3rd February, 1959, immediately after the first cut taken the previous day. Other cuts were taken on 8th April, 1959, 30th June, 1959, and 20th October, 1959. Examination of the results showed that responses were similar in the first two (wet season) cuts, the second two (dry season) cuts and the results in Table III are presented grouped in that way. Samples for laboratory analysis were taken from certain treatments for all except the first cut, and the results are presented in Table IV.

TABLE III

Wet Season Yields

In 100 *lb. Green Weight per acre*

	N_0	N_1	N_2	P_0	P_1	P_2	*Mean*
S_0	813	990	996	810	900	1,089	933**
S_1	443	686	663	383	746	663	597
S_2	646	803	853	610	963	733	768**
P_0	510	653	636				
P_1	753	920	936				
P_2	636	903	940				
Mean ..	633	825**	837**	601	869**	828**	766

L.S.D. Marginal Means P.0.05 = 95. P.0.01 = 149.
Coefficient of Variation = 10.6%.

Dry Season Yields

In 100 *lb. Green Weight per acre*

	N_0	N_1	N_2	P_0	P_1	P_2	*Mean*
S_0	69	70	69	65	70	72	69
S_1	65	76	63	63	73	68	68
S_2	83	75	78	70	97	69	78*
P_0	68	67	63				
P_1	82	72	85				
P_2	67	82	61				
Mean ..	72	73	70	66	80*	70	72

L.S.D. Marginal Means P.0.05 = 9.09 P.0.01 = 14.26
Coefficient of Variation = 10.5%

TABLE IV

Percentage Composition of Napier Grass

Wet Season: Second Cut Only

Further Treatment	*Dry Matter*	*Crude Protein*	*Nitrogen*	*Phosphate*	*Potash*
Nil	16.06	7.56	1.21	0.11	4.07
N_2	16.73	10.88	1.74	0.13	3.68
P_2	19.97	6.19	0.99	0.28	3.93
N_2 P_2	15.39	7.75	1.24	0.21	3.72

Dry Season: Mean of third and fourth Cuts

Fertilizer Treatment	*Dry Matter*	*Crude Protein*	*Nitrogen*	*Phosphate*	*Potash*
Nil	24.69	8.91	1.42	0.09	3.31
N_1	27.06	6.37	1.02	0.07	3.06
N_2	25.61	8.06	1.29	0.07	3.02
P_1	26.87	6.28	1.00	0.08	3.29
P_2	25.81	5.66	0.90	0.07	2.89
N_1 P_1	27.18	5.44	0.87	0.07	3.02
N_2 P_2	26.71	5.62	0.90	0.07	3.04

Crude Protein, Nitrogen as N., Phosphate as P. and Potash as K. as per cent. dry matter.

Inspection of the results shows that the application of nitrogen and phosphate fertilizers each increased the wet season production significantly (P=0.01) and almost equally, but that the difference between the two levels of application, 300 and 600 lb. of fertilizer, was in neither case significant. In the ensuing dry season the lower level of phosphate application is shown as increasing production significantly (P=0.05), but this is questionable since the higher level of phosphate does not show a corresponding response. The fertilizer application also materially affected the composition of the wet season herbage, the higher nitrogen level raising the crude protein percentage from 7.56 per cent. to 10.88 per cent. The higher phosphate level raised the phosphate composition from 0.11 per cent. to 0.28 per cent.; thus more than doubling it. The two high levels of fertilizer together, did not appear to improve the crude protein percentage but did raise the amount of phosphate in the harvested material.

These effects of fertilizer on the grass composition were not carried through into the dry season.

In the wet season the 3 ft. × 3 ft. spacing was significantly superior (P=0.01) to the similar plant population per acre spaced at 9 ft. × 1 ft., and both of these spacings were superior to the much lower plant population provided by the 9 ft. × 3 ft. spacing. In the dry season the 9 ft. × 1 ft. treatment was better than either of the others (P=0.05).

The treatment effects shown in the wet season dominated the total production for the whole year, because by far the greater proportion of the yield was achieved then. However, the dry season yields, although small by comparison, are important as they provide several tons of green material per acre as supplementary food at a time when stock most appreciate it.

Extract from Report of the Agricultural Chemist, Chitedze

THE FEEDING VALUE OF NATURAL BUSH AND DAMBO (VLEI) GRASS PASTURES

Samples of these two types of pasture consisting of mixed grasses taken from areas where animals had been seen grazing were submitted at frequent intervals throughout the year in order to study variations if any in their feeding value. The results obtained on analysis are given below in Table V.

TABLE V

Comparative Feeding Values of Bush and Dambo (Vlei) Grass Pastures

(100% *dry matter basis*)

BUSH

Lab. No.	*Date*	*Dry Matter*	*Ash*	*Crude Protein*	*Crude Fibre*	*P*	*K*
707	1/12/58	71.09	12.49	4.44	32.61	.18	2.28
720	15/ 1/59	19.73	11.16	9.50	29.03	.24	2.96
740	2/ 3/59	22.77	14.41	7.60	32.44	.21	2.53
763	4/ 4/59	33.06	9.34	6.06	34.11	.16	1.40
778	5/ 5/59	45.11	7.81	5.44	32.79	.14	1.00
930	11/ 7/59	48.10	10.38	3.00	39.28	.07	.70
931	15/ 8/59	70.38	8.55	2.38	40.62	.13	.74
945	7/ 9/59	53.33	11.18	3.25	37.70	.09	.53
957	17/10/59	61.02	9.48	2.31	41.24	.07	.35

DAMBO (VLEI)

Lab. No.	*Date*	*Dry Matter*	*Ash*	*Crude Protein*	*Crude Fibre*	*P*	*K*
705	1/12/58	68.77	14.16	4.44	32.78	.10	.68
721	15/ 1/59	25.37	9.73	9.25	30.29	.24	2.16
728	9/ 2/59	29.12	7.61	6.00	35.35	.16	1.90
841	4/ 6/59	51.03	11.08	3.00	35.52	.14	1.13
929	11/ 7/59	52.24	12.22	3.81	37.13	.11	1.17
933	13/ 8/59	56.18	12.81	3.31	40.67	.12	.70
944	7/ 9/59	74.68	10.20	2.63	42.17	.10	.50
955	7/10/59	64.40	10.50	2.19	38.13	.10	.47

The results show that there is an almost simultaneous fall off in food value in both types of pasture as the dry season progresses, and though expected in the bush grasses, it was not thought that this would be nearly as rapid in those from the dambo where soil moisture supplies are available for much longer into the dry season.

MIXED FARM UNIT AT BVUMBWE

After costing this unit for three years, it is apparent that certain modifications to the system are required.

The cost of production of arable crops was satisfactory only if the target yield per acre was maintained. Thus when maize yielded 20 bags per acre, the cost was only 15s to 17s per bag and soya at 10 bags per acre cost 35s to 40s per bag. The maize yield was attained without difficulty and by the introduction of a locally produced hybrid variety, Mtenga, it will be possible to exceed the 20 bag mark. It has not been so easy to attain the target yield of 10 bags of soya per acre although previous experimental plots had shown that as much as 15 bags could be expected; in 1959 poor germination of seed, cut-worm attacks and poor rains reduced the yield to 7½ bags at a cost of 61s per bag which was more expensive than the cost of locally purchased protein feed. Thus in the case of the soya crop more efficient methods of production on the field scale are needed.

Silage was produced from Rhodes grass leys at a cost of 28s–6d per short ton which is a reasonable cost for a good grass silage. The protein content was, however, lower than usual being only 4.9 per cent. on a dry weight basis.

There are indications that, as a result of the rotation adopted, fertility is being improved. Thus, for example, Rhodes grass yields in leys planted after one complete rotation have increased, a silage cut in the rains gave 14 tons per acre of green matter with an excellent aftermath on two dressings of 200 lb./acre of sulphate of ammonia. Fiji Clover and Stylo intersown in this ley did not, however, survive grazing early in the season and further study is needed of the management of such a grass/legume ley.

The livestock accounts showed that a small 100-acre unit as at Bvumbwe cannot make a profit if the milk is to be converted to butter. The price obtained for butter is 3s–9d per lb.; the cost of production of milk is 2s–6d per gallon including overheads. Thus, with 1½ to 2 gallons of milk going to one pound of butter, this is not a profitable proposition. Additional income from pigs would not have made up the difference although they were fed mainly on skim milk and surplus maize. The position was further aggravated in that there is not a ready outlet either for porkers or baconers. Growth rates of pigs fed on skim milk were very satisfactory (see pig-feeding experiment detailed later in this report).

The alternatives which have to be pursued are: (1) The entire production of the unit to be geared to whole-milk sales and the pig unit to be discarded; (2) Butter-making to continue but skim milk to be sold on the market; the pigs would be discarded.

Grass Fertilizer Trials, Bvumbwe

The nitrogen/phosphate/lime experiment on a permanent pasture reported last year continues. Yields were poor, not exceeding 8.5 short tons per acre of dry matter per annum taken on three grazings and sowings. Significant responses were obtained from all rates of nitrogen fertilizer; applications of lime, phosphate and sulphur resulted in no increases at this stage.

A grass/legume/fertilizer experiment has been established with the object of comparing the effect of a legume with a nitrogenous fertilizer on grass production; records will be taken next season.

Irrigated Pastures

An acre each of lucerne and a chicory/clover/fescue mixture were established last year at Bvumbwe to provide a green cut under irrigation in the dry season. The plots were irrigated with the aid of data from an evaporation pan, 2 inches of water being applied when the calculated deficit rose to that amount. The results of the experimental plots will be reported next year.

Acknowledgment is made to Messrs. Nyasa Tea Estates for the loan of an oven and to Messrs. Nchima Tea and Tung for the loan of a mower for use in connection with these experiments.

Pig-Feeding Experiment, Bvumbwe

OBJECT

To compare effect of a balanced ration containing fish meal with a ration of skim milk and maize, the experiment to last over a period of 14 weeks, i.e. from the age of 8–22 weeks.

DESIGN

A cross-over design using six pairs of pigs, one heavy, one light in each pair.

TREATMENTS

Each ration was tested on every pig by feeding it during either the first or the second period of seven weeks.

MEASUREMENTS

Pigs were weighed weekly and growth rate on each ration at each period was measured.

RESULTS

The pigs started with a mean weight of 38 lb. (ranging from 32 to 44 lb.). Growth rates on both rations were greater than had been experienced previously and, at the end of the experiment, live weight varied from 121 to 181. lb. with an overall mean of 154 lb. In both periods skim milk proved the significantly superior feed. (See table below.) The difference between the weight increases in the two periods was not significant.

Growth Rates of Fattener Pigs

Increase in weight (lb.)

Treatment	*Age 8–15 weeks*	*Age 15–22 weeks*	*Means*
Balanced Ration	52.3	48.0	50.7
Skim Milk	72.7	57.2	64.9
L.S.D. between means P=0.05			10.6

Coefficient of Variation=5.1 per cent.

TEA

Joint Tea Research Committee

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Resident Scientific Staff

Senior Tea Research Officer	.. ..	D. H. LAYCOCK, M.SC. (Leeds), A.I.C.T.A.
Tea Research Officer	..	*Vacant*
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Departmental Non-Resident Staff Partially concerned with Tea Experimental Work

Chief Agricultural Research Officer	..	S. T. HOYLE, O.B.E., B.A. (Cantab.)
Agricultural Chemist	..	C. V. CUTTING, B.SC., PH.D. (London), F.R.I.C.
Soil Physics	..	R. A. WOOD, B.SC.
Laboratory Technician	..	R. C. PEAK

Associated Staff at Cambridge University

Biochemist	..	D. BENDALL, PH.D.

Transfer, Leave and Appointments

Senior Tea Research Officer	.. ..	D. L. DOWNIE left in July, 1958, for leave pending transfer to West African Institute for Oil Palm Research, Nigeria. D. H. LAYCOCK appointed with effect from 30th July, 1958.
Agricultural Supervisor, Swazi ..	..	I. P. Scarborough on U.K. leave February to October, 1958
Agricultural Supervisor, Cholo ..	..	G. F. Craske appointed with effect from 25th May, 1959.

Acknowledgments

As in previous years estate managers have placed tea at our disposal for field experiments and for fermentation investigations. To all, we wish to express our very grateful thanks for the time and trouble they have taken on our behalf.

Introduction

Unless otherwise stated this report refers to the crop year July, 1958, to June, 1959. Throughout the labour supply was adequate for all purposes.

In retrospect the season under review was the most frustrating and worrying one experienced for a long time. From 1st July, 1958, the European staff complement on paper rose from four to five but abnormally concentrated leave requirements and the Senior Tea Research Officer's transfer to Nigeria, meant in fact that only two experienced members were on duty for the first half of the season and three thereafter. Mr. Craske arrived shortly before the end of May, 1959, and after a month's residence at Mimosa was posted to the new sub-station in Cholo. The Tea Research Officer's appointment remained vacant throughout the year.

In these circumstances it became impossible to maintain the previous rate of research work and practically all experimental efforts were routine. The plant improvement programme had to be placed on a care-and-maintenance basis. Non-routine examination of experimental records had been planned but was found impossible and little progress was made in the fundamental examination of tea growth in relationship to climate.

The Senior Soil Conservation Officer prepared a land usage plan for the Cholo sub-station and developmental work there was supervised from Mimosa. The major roads are formed, twelve labourers' houses, two African staff houses and an office-store are built; the first experimental areas are ringbarked and a nursery of 50,000 plants established. Tea planting will start with the 1960/61 rains.

During the year the Senior Tea Research Officer visited the Northern Province tea plots at Mzuzu on three occasions and spent two weeks in the Rhodesian tea areas. Estate visits had to be reduced to a minimum other than those for purely advisory purposes.

Two new uniformity trials were started at Mimosa ready for experimental treatments to be applied during the next season. The first will compare the relative effects of sulphate of ammonia and urea, and the second is of a more academic nature designed to examine on a small scale, wind-break effects on the yields of tea.

The Emergency caused little interruption to routine field work. The only losses were one plucking round's records from the Bandanga N.P.K. experiment and the uprooting of a few gypsum soil moisture blocks at Mimosa.

Survival of Young Tea

Attempts in the past to correlate survival of young tea with total rainfall for the dry season and with plant population were not entirely satisfactory. Although close correlations were obtained for any one season between rainfall, population and deaths, no general function was obtained which would account for between-season differences over a number of years.

A new approach to the problem using evaporation records combined with rainfall appears to offer a more satisfactory solution and the preliminary functions so far obtained using age, available soil moisture and evaporation data, offers theoretical expectations of death in significant agreement with actual deaths for differing population over different seasons.

The theoretical extension of the function suggests that more protection might be offered to young tea by a later pruning than that commonly done at present and that after the first ten years there is little danger of death to even unpruned tea but before this an extended cycle might lead to deaths. These somewhat unconventional suggestions require confirmation by field experiment.

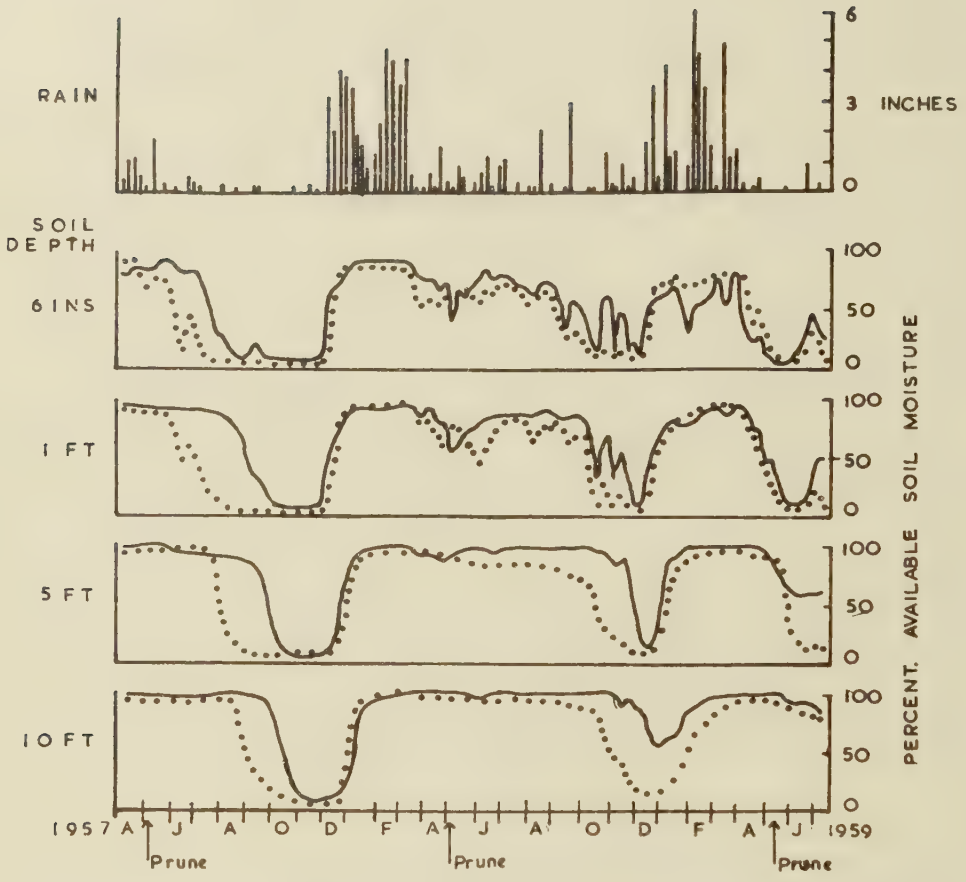

FIGURE 1. Soil moisture movements under mature tea Swazi.
Pruned ——— . Unpruned ••••••.

Soil Moisture Studies

(i) SOIL MOISTURE MOVEMENTS UNDER MATURE UNSHADED TEA, SWAZI

As in previous years routine measurements were taken at frequent intervals of soil moisture movements under mature tea using gypsum blocks and a resistance meter. Half of the tea is pruned in alternate years at the beginning of each dry season. Measurements were made at foot intervals down to 10 feet but in May, 1959, extra blocks were sunk at 15 feet and 17 feet 6 inches.

Data from April, 1957, to June, 1959, are presented graphically in fig. 1, wherein the unbroken curve represents readings under pruned tea and the broken line readings under unpruned tea which carries a full canopy of leaf throughout the dry season. The " average " dry season is taken as extending from the first of May to mid-November.

The 1957 dry season was the hardest for many years and considerable drying occurred at all depths sampled for long periods. Pruning delayed the use of moisture reserves for approximately ten weeks in contrast with no prune. The onset of the following rains were good and by the end of January the profile was filled to at least ten feet. However the rain came to an end at the end of February and by pruning time the profile had begun to dry at all depths. Fortunately better than average quantities of rain fell thereafter and in contrast to the 1957 drought the profile remained comparatively well filled throughout the majority of the dry season until drying eventually took place at depth during November and December.

Thereafter the main rains were late, badly distributed and below average. The profile down to 10 feet (the deepest depth then measured) did not fill until January and following a very early end to the main rains in mid-March the profile at all depths began to dry again by May, some months earlier than in previous years.

It had been planned to translate, before the end of the season, these data into units of soil water used and compare trends with evaporation data. Staff shortages have prevented this.

Nevertheless the crude data indicate various points. Pruning, as might be expected by removal of the transpirational surface, delays the use of moisture reserves and does this for approximately ten weeks. Although judiciously timed annual pruning appears to be an essential insurance scheme for the protection of tea up to ten years old (see previous section) all experimental evidence at present demonstrates that higher yields can be obtained from mature tea by the use of extended pruning cycles providing nitrogen is adequately supplied. It would be wrong therefore to base the length of a pruning cycle for mature tea upon the soil moisture curves simply because pruning delays the onset of drying out and to conclude therefrom that an annual cycle is desirable. In terms of yield, extended cycles are more efficient. Rather, these curves support field evidence that pruning of mature tea should take place in early dry season whilst the profile has still adequate moisture. To delay pruning until mid-dry season as was the custom until recent years, results in a delayed break away from prune which in turn means the unprotected framework is subject to sun-scorch at the hottest time of the year. A body of *ad hoc* evidence is now being built up to show that yield trends from mature tea are increasing as a result of earlier pruning. As a working rule the older the wood pruned the longer it takes for regrowth and consequently the earlier should be the prune. A heavy down-prune into very old wood should take place in mid to late rains whilst the profile is still full.

The Agricultural Chemist, Chitedze, dissected root systems from these plots during May and as a result additional blocks were sunk to 17 feet 6 inches.

There is conclusive evidence that the water at depth is well below normal at present. It appears possible that severe drying at depths below ten feet occurred during 1957 and that average or poor rains since then have not succeeded in replenishing the profile.

Paradoxically the yield for the current season has been well above average and in lieu of quantitative data it appears that the below average rains have nevertheless been sufficient to maintain moisture reserves within rooting depth at adequate levels for climatic demands. The latter, because of the warmer and less cloudy weather, have led to higher evaporation rates than usual. From some time past it has been known that total seasonal rainfall is poorly correlated with yield and it is becoming increasingly possible that a good quantitative correlation will be obtained between yield and the balance of rainfall against evaporation.

(ii) SOIL MOISTURE MOVEMENTS UNDER YOUNG TEA WITH AND WITHOUT INTERPLANTED PERMANENT SHADE TREES, MIMOSA

At the beginning of this season gypsum soil-moisture blocks were sunk at 1 foot, 5 feet and 10 feet depths in each of the 64 plots of the Shade Tree Experiment at Mimosa. The main treatments in this experiment are no-shade tea compared with tea shaded with *Glyricidia maculata, Grevillea robusta* or *Albizzia gummifera*. The *Glyricidia* has been pruned to form upright shade trees but is not otherwise lopped as in Ceylon practice.

The tea is now 8½ years old and pruned annually. Shade trees are one year younger, offering in terms of shade a canopy approximating that which is expected at maturity.

Each of the 16 main treatment shade plots are split into four sub-plots and compared with suitable confounding, the effects of four nitrogen rates with and without phosphate or potash dressings. During the first season of observing moisture movements, no effects were apparent due to nutrient dressings but obvious effects were due to shade trees. Data taken according to shade treatments are shown graphically in fig. 2, for the past and first season of recording.

In the foot depth profile there appears to be little difference in moisture movements between any of the shade treatments but at the 5 feet and 10 feet depths *Albizzia* has dried the soil more than the other three treatments.

In this experiment the tea has yet to reach maturity. Yields obtained are described in a subsequent section and *Albizzia* has not depressed yield to the lowest level as might be surmised from these moisture graphs. To reiterate the warning given in last year's report it would be unwise, until more evidence is collected, for estates to embark on rash shade removal programmes from young or mature tea. Undoubtedly excessive shade can reduce the growth and yields of young tea but it is felt that at our present state of knowledge judicious shade management is called for rather than drastic removal.

Further comments on the shade problem are offered later in this report.

Pruning Experiments

(i) LENGTH OF PRUNING CYCLE AND TYPE OF PRUNE, SWAZI

At the end of the season this experiment completed 18 consecutive years of recording and compares the following treatments:

1C Annual clean-prune

1A Annual cut-across prune, removing approximately half the top hamper with no subsequent cleaning.

1R As for (1A) but the centres of the bush cleaned to an 18 inch diameter following cut-across.

2C Two yearly clean-prune.

2A Two yearly cut-across whereby approximately half the top hamper is removed in alternate years with no subsequent cleaning.

3C Three yearly clean-prune.

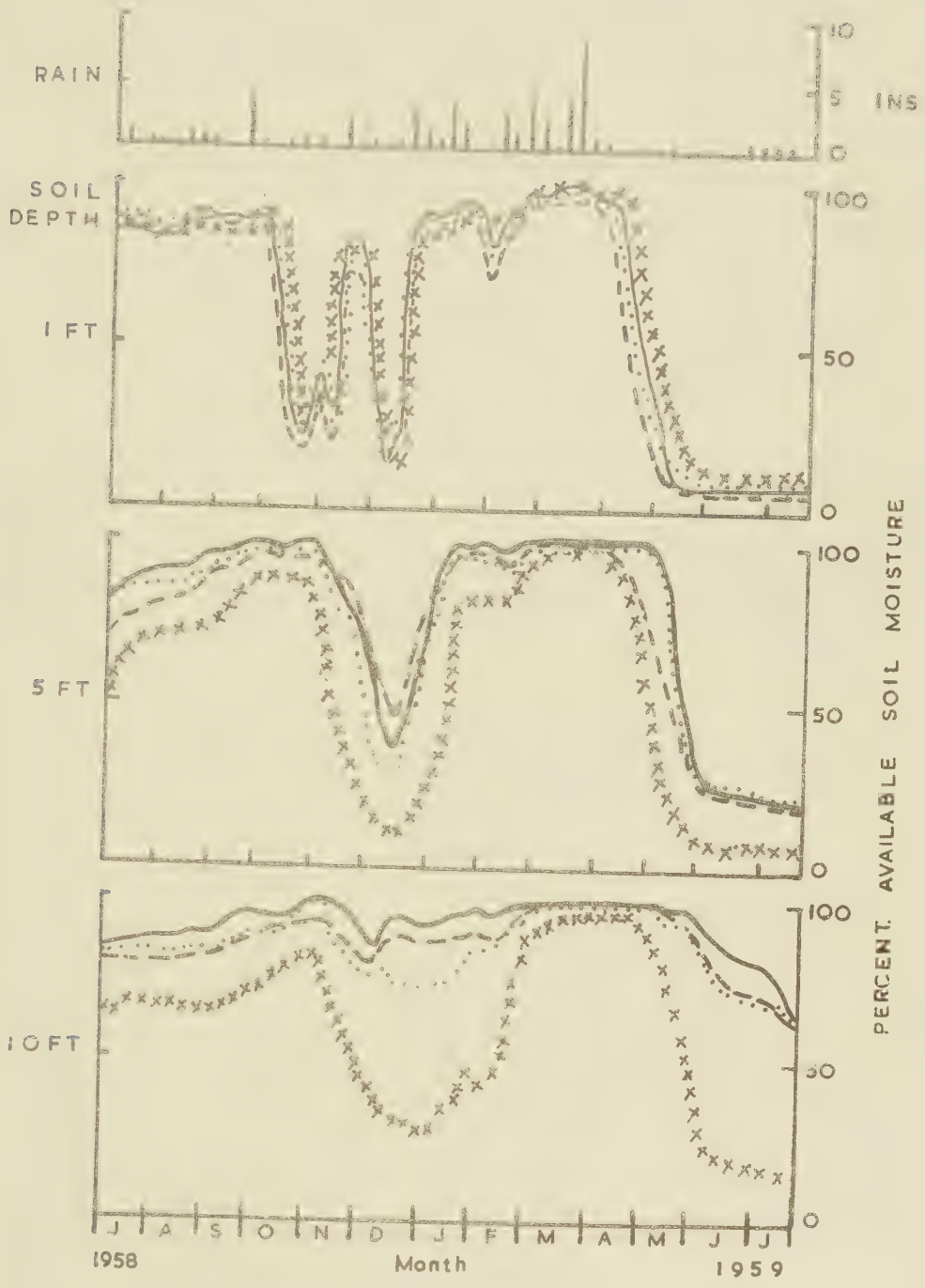

FIG 2. Soil moisture movements under tea with and without shade trees. No shade ———. Glyricidia – – – –. Grevillea ••••••. Albizzia gummifera X X X X.

During the past three years it was clear that the frameworks of the annual and two yearly clean pruned plots had grown too high and whippy and following a resting period these plots were heavily down-pruned to 10 inches in February, 1957.

Total yields for the past three seasons are given in Table I.

TABLE I

Yields in lb. m.t.p.a. according to Six Different Types of Prune

	Clean-prune			*Cut-across*			L.S.D., P=		
Treatment	*Annual*	*2 yearly*	*3 yearly*	*Annual*	*Annual + centring*	*2 yearly*	0.05	0.01	0.001
Yield ..	1314	1987	4032	3734	3557	4131	437	596	807

C.V.% 1956/59, 11.61%

All treatments have significantly outyielded the down-pruned yearly and two yearly clean-pruned treatments during the past three years. Following the down-prune the two yearly clean-prune cycle has outyielded the annual clean-prune.

More interesting and informative than the short term data from the past three years is the relative positions of the three yearly running means for each treatment throughout the life of the experiment. These are presented in Table II according to order of yield and for convenience treatments are coded according to the list of treatments given above.

TABLE II

Yield Order of Three Yearly Running Means by Treatments

Season	*Yield order of 3 yearly running means*					
	1st	2nd	3rd	4th	5th	6th
1941/42 ..	—	—	—	—	—	—
1942/43 ..	—	—	—	—	—	—
1943/44 ..	2A	1A	3C	1R	2C	1C
1944/45 ..	3C	2A	2C	1A	1R	1C
1945/46 ..	3C	2C	2A	1A	1C	1R
1946/47 ..	2C	1C	3C	1A	1R	2A
1947/48 ..	2C	1C	3C	1A	1R	2A
1948/49 ..	1C	2C	3C	1A	1R	2A
1949/50 ..	2C	1C	3C	1A	1R	2A
1950/51 ..	2C	1C	3C	1A	1R	2A
1951/52 ..	2C	3C	2A	1R	1A	1C
1952/53 ..	2A	3C	1R	1A	2C	1C
1953/54 ..	2A	3C	2C	1R	1A	1C
1954/55 ..	2A	3C	2C	1R	1A	1C
1955/56 ..	2A	3C	2C	1R	1A	1C
1956/57 ..	2A	3C	1A	1R	2C	1C
1957/58 ..	2A	3C	1A	1R	2C	1C
1958/59 ..	2A	3C	1A	1R	2C	1C

Before 1950/51, 35 lb. nitrogen (N) per as acre sulphate of ammonia was applied annually and thereafter this rate was increased to 80 lb. N. All plots receive identical fertilizer treatments.

The yield trends shown in the above table tend to confirm the nitrogen and pruning cycle interaction being found more specifically in the Thornwood Experiment. Prior to the increased nitrogen dressing the longer cycles and those carrying consistently the most top hamper were the lowest yielders, but thereafter the trend was reversed and the lightest prune of all, the two yearly cut-across cycle, has changed places (as the highest yielder) with the hardest and most frequent prune of all, the annual clean-prune.

Table III presents the mean yearly yield harvested for the 18 years.

TABLE III

Mean Yield Per Year in lb. m.t.p.a. for 18 years according to Pruning Method

Treatment	*Yield p.a.*
3 year clean-prune	1,204
2 year cut-across	1,185
1 year cut-across	1,133
2 year clean-prune	1,115
1 year cut-across with centring	1,112
1 year clean-prune	982

(ii) PRUNING CYCLES ON LOCAL JAT TEA, THORNWOOD ESTATE

This experiment completed its seventh year at the end of the season and compares in factorial combination three pruning cycles, three nitrogen rates and three tipping heights.

At the start of the season all plots were clean-pruned, there having been previously two complete three-yearly cycles, three two-yearly cycles and six annual prunes. Significant differences due to prune were obtained for the seasonal yields as can be seen in Table IV. The two- and three-yearly cycles have significantly outyielded the annual cycle, there being no significant differences in yield between the two extended cycles.

There are no significant differences between length of pruning cycle considered as main treatments for the cumulative yields over seven years, when averaged onto a yearly basis.

TABLE IV

Yields in lb. m.t.p.a. according to Pruning Cycles, Thornwood Estate

Cycle	*Yearly*	*2 yearly*	*3 yearly*	L.S.D. 0.05	L.S.D. 0.01
1958/59 season	1,129	1,386	1,489	185	251
Average per year for 7 years	1,081	1,088	1,104	118	161

C.V.% 1958/59, 20.00%. C.V. 7 seasons 15.68%

In this season when all plots were recovering from clean-prune the interaction between nitrogen rate and pruning cycle was not as effective as in seasons when unpruned plots are available. Nevertheless there are residual effects from previous seasons which continue to support the observation that longer cycles make better use of nitrogen and conversely that longer cycles cannot be supported upon low nitrogen.

TABLE V

Yield in lb. m.t.p.a. for the Season 1958/59 according to Pruning Cycle and Nitrogen Rate

Pruning Cycle	*Nitrogen lb. N. p.a.*		
	40	80	120
Yearly	819	1,103	1,466
Two yearly	950	1,269	1,940
Three yearly	893	1,535	2,040

At the end of the first six seasons when all plots were clean-pruned, measurements were made on wood growth within the frameworks. Of the factors measured, a significant and positive multiple correlation was found between previous yield and the areas of the frameworks and the numbers of branches within these. Mean branch diameter or total wood area within the framework did not offer a significant contribution to the regression. Full details of the correlation are to be published in *Tropical Agriculture*.

Tipping Experiments

(i) TIPPING LOCAL JAT TEA, THORNWOOD ESTATE

Tipping at 2, 4 or 6 inches above the prune in the Thornwood Experiment caused significant losses in crop for each upward step during the tipping phase following prune but afterwards these differences were reduced during the main crop season and are not significant for either the full seasonal yields or for the seven seasons' crop. These results agree with previous experience.

Fertilizer Experiments

This section deals with fertilizers applied to unshaded tea planted at one spacing in any one experiment. The interplay of fertilizers with other management methods is reported elsewhere. Unless otherwise stated, experiments comparing the effect of only one fertilizer have the other two major fertilizers equalized over all plots.

(i) N.P.K. EXPERIMENT ON YOUNG INDIAN TEA, MIMOSA

This experiment was planted in December, 1953, at Mimosa and compares the effect of increasing rates of the three major nutrients as detailed in Table VI. Until this season sulphur was equalized over all plots by the addition of flowers of sulphur as necessary to the fertilizer combination.

TABLE VI

Nutrient Rates according to Age lb. N. P_2O_5 or K_2O per acre

Date applied	*Nutrient lb. p.a.*					
	n_0	n_1	p_0	p_1	k_0	k_1
December, 1953	—	—	—	Tea	planted	—
June, 1954*	10	20	nil	10	nil	10
December, 1954*	15	30	nil	10	nil	10
November, 1955*	20	40	nil	15	nil	15
November, 1956*	25	50	nil	20	nil	20
November, 1957*	30	60	nil	25	nil	25
November, 1958	35	70	nil	30	nil	30

*Sulphur equalized over all plots

Yields for the past season are detailed in Table VII and there are no significant differences due to fertilizer rates.

TABLE VII

Yield lb. m.t.p.a. according to Fertilizer Treatments

Nutrient	*Nitrogen (N)*		*Phosphate (P_2O_5)*		*Potash (K_2O)*	
lb. per acre	35	70	nil	30	nil	30
Yield 1958/59	879	873	859	892	881	870

C.V.%, 15.5%

There has been no significant differences due to fertilizers throughout the life of this experiment and leads to the conclusion given previously, that adequate sulphur is the essential nutrient during the early years. At the same time it must be remembered that these plots have been annually clean-pruned to-date and this can perhaps be expected to reduce nitrogen responses.

This experiment had included in its design at planting, a pair of blank treatments for use at a later date as necessary. The significant positive regression between framework area and the number of branches with previous yield obtained from the Thornwood Experiment, together with the yield trends from the long term Swazi Experiment, lead to the suggestion that there is a possible interplay between type of prune and nitrogen efficiency. Confirmatory evidence (as opposed to historical agreement) might be obtained by comparing the yields of clean-pruned bushes against bushes pruned at the same pruning height but with no cleaning if provision is also available in the experiment for the imposition of differing nitrogen rates. The blank treatments have thus been brought into use from the beginning of this season.

(ii) THREE-CUBED FACTORIAL N.P.K. ON MATURE INDIAN TEA, SWAZI (MLANJE DISTRICT)

At the end of the season this experiment had received its eighth consecutive set of fertilizer treatments. It compares in factorial combination, three levels of each of the major fertilizers on poor unshaded Indian type tea spaced at four feet square.

TABLE VIII

Effect of N.P.K. on Yields at Swazi Yields in lb. m.t.p.a.

Nutrient	N			P_2O_5			K_2O		
lb. per acre	40	80	120	0	30	60	0	30	60
Yield lb. m.t.p.a... ..	875	1,137	1,483	1,158	1,138	1,199	1,139	1,204	1,152
L.S.D.	P=0.001=208			none			none		

C.V.%, 1958/59. 14.13

The differences due to each upward step in nitrogen are significant at P=0.001. From N40 to N80 the return in tea for each lb. of added nitrogen was 6.60 lb. and from N80 to N120, 8.53 lb.

This increase in response between the two higher rates is of interest. The experiment consists of two complete replications which are pruned on a three-yearly cycle but each out of step by one year in order to give some phasing over seasons. At the beginning of this season one replication was clean-pruned following a heavy down-prune three years previously, and the second was one year behind and completed its third unpruned year following a similar down-prune. This had led to differing responses to nitrogen according to prune and in agreement with experience from the Thornwood Experiment.

TABLE IX

Response from 1 lb. Nitrogen according to Age from Prune in lb. m.t.

Pruning	*Response in lb. tea*	
	from N40 *to* N80	*from* N80 *to* N120
Newly pruned	6.55	5.05
3rd and last year from prune	6.65	12.01
Mean	6.60	8.53

The most efficient use of nitrogen has been obtained from the unpruned tea between the two higher rates.

(iii) THREE-CUBED FACTORIAL N.P.K. ON NAMIREME ESTATE (CHOLO DISTRICT)

The fertilizer treatments are replicas of those in the Swazi Experiment. The whole of this experiment is pruned on a two-yearly cycle at one date. During the season it was in its first year following prune and yields for the season according to fertilizer treatments are given in Table X.

TABLE X

Effect of N.P.K. on Yields at Namireme Estate: Yields in lb. m.t.p.a.

Nutrient	N			P_2O_5			K_2O		
lb. per acre	40	80	120	0	30	60	0	30	60
Yield m.t.p.a.	474	629	741	587	615	642	623	617	604
L.S.D.	P=0.001=107			none			none		

C.V., 13.81%

Each upward step in nitrogen has caused significant increases in crop; the response for each 1 lb. of nitrogen from N40 to N80 being 3.90 lb. of tea and from N80 to N120, 2.80 lb.

The difference of 55 lb. between the highest and lowest rates of phosphate applications fails to reach significance at P=0.05 by 4 lb.

It is of interest to note that two seasons ago it was recorded that an indication o a response to phosphate with pruning weights was obtained. The return for each 1 lb. of added phosphate from 0 to 30 P_2O_5 is 0.93 lb. of tea and from 30 to 60 lb. P_2O_5 0.90 lb. Economically the return equals the expenditure.

(iv) SULPHATE OF AMMONIA ON LOCAL JAT TEA, THORNWOOD ESTATE

Superimposed on the three pruning cycles and three tipping heights in this experiment are three nitrogen rates. Average yields according to nitrogen rate are given in Table XI.

TABLE XI

Effect on Yields of Increasing Nitrogen Rates, Thornwood Estate

lb. N.p.a.	40	80	120	L.S.D.
1958/59 Yields	887	1,302	1,815	P=0.001=337
Average for 7 seasons	807	1,082	1,384	P=0.001=216

C.V.% 1958/59=20.00% C.V.%, 7 seasons=15.68%

Each upward step in nitrogen has caused significant increases in yield and the responses in lb. made tea for each added 1 lb. of nitrogen are for the past season, 10.38 and 12.83 from N40 to N80 and from N80 to N120 respectively. For the seven seasons the corresponding responses are 6.87 and 7.55 lb.

As shown in Table V longer cycles due to residual effects have made more efficient use of nitrogen even in the year when all plots are recovering from prune. The average response from N40 to N120 for the annual cycle is 8.09 lb. of tea, for the two-yearly cycle 12.38 and for the three yearly cycle 14.33 lb.

(v) TWO-CUBED N.P.K. EXPERIMENT, LAUDERDALE ESTATE (MLANJE DISTRICT)

This experiment received its second application of fertilizers and was recorded at intermittent plucking rounds. Consequently yields in Table XII are recorded as plot yields of made tea and not as per acre yields. These yields have been adjusted by co-variance on uniformity yields.

TABLE XII

Effect of N.P.K. on Yields at Lauderdale Estate, Mlanje District

Yields are Plot Yields in lb. made tea

	Nutrient					
	N		P_2O_5		K_2O	
lb. per acre	0	80	0	60	0	60
Yield made tea	93	122	100	115	108	107
L.S.D.	P=0.01		none		none	

Only nitrogen has caused significant increases in yield.

(vi) TWO-CUBED N.P.K. AT BANDANGA ESTATE (CHOLO DISTRICT)

This experiment, similar to that at Lauderdale, received its third annual set of fertilizer treatments. Yields are recorded in Table XIII and only nitrogen has caused significant increases in yield.

TABLE XIII

Effect of N.P.K. on Yields at Bandanga Estate, Cholo Distric

	Nutrient					
	N		P_2O_5		K_2O	
lb. per acre	0	80	0	60	0	60
lb. m.t.p.a. 1958/59	317	601	448	470	455	463
L.S.D.	P=0.001		none		none	

The response in tea was 3.55 lb. for each added pound of nitrogen in comparison with the Namireme response of 3.34.

Weedkillers

Work with weedkillers and the formal experiment described in last year's report had to be abandoned because of staff shortages and new commitments in Cholo. There are no conclusions to draw from the formal experiment other than in comparison with hand weeded tea no significant differences in numbers of deaths were obtained from weedkillers, at the rates described in last year's report.

Spacing of Tea

(i) GENERAL

As a result of the 1957 drought the spacing experiments suffered deaths which were abnormally high and which were in proportion to the numbers of plants per acre before the drought. The vacancies were infilled during this season but the early end to the main rains and the subsequent very dry weather experienced up to the time of writing has resulted in high casualties amongst the infills. The full losses will not be known until the end of the dry season but it is already apparent that the infilling programme will be a comparative failure and will need repeating to a large extent next season.

The future of these experiments is still problematic although systematic responses between yield and the surviving numbers of plants in bearing is apparent. Time alone will tell what useful information they can offer when the tea reaches maturity.

It was intended next season to uproot part of one field at Mimosa and begin a three-year replacement programme of one spacing experiment. The very high numbers of deaths now being experienced with supply plants means that nursery material will not be available for beginning this replacement next season.

(ii) FOUR SPACINGS AND FOUR SULPHATE OF AMMONIA RATES, MIMOSA

This experiment compares tea at four spacings and receiving four nitrogen rates. Yields for the past season according to spacing and nitrogen treatments are recorded in Tables XIV and XV.

TABLE XIV

Yield in lb. m.t.p.a. according to Four Spacing Rates

Theoretical plants p.a.	2,720	3,630	4,650	7,260	L.S.D.
Actual plants in bearing	2,285	2,973	3,718	5,682	None
Yield lb. m.t.p.a.	1,553	1,561	1,607	1,741	

C.V.% 12.78

No significant differences due to spacing are available this year but the yields are in close relationship to the numbers of plants surviving the 1957 drought and still in bearing. This regression yields an r^2 value of 0.9683.

TABLE XV

Yield in lb. m.t.p.a. according to Four Nitrogen Rates

lb. N.p.a.	40	80	160	240	L.S.D.
Yield lb. m.t.p.a.	1,586	1,595	1,652	1,629	none

There are no significant differences due to nitrogen.

There are no significant interactions between spacing and nitrogen rate.

(iii) COMPLEX EXPERIMENTS—MIMOSA

There are three complex experiments, each having the same treatments but planted at yearly intervals over three successive years. All replications suffered badly from the 1957 drought and deaths were in accordance with age, pruning date and spacing.

Table XVI presents yield data according to plant population. In conformity with the previous experiment the yields obtained are in close relationship to the numbers of plants in bearing throughout the season.

TABLE XVI

Yields in lb. m.t.p.a. from Three Complex Experiments according to Age and Spacing

Experiment	*Age at end of season*	*Theoretical plants p.a.*	*Actual in bearing*	*Yield lb. m.t.p.a.*	L.S.D. 0.05	L.S.D. 0.01	r^2 *yield/ plants*	C.V.%
I	6.5 yrs	2,720	1,930	786				
		3,630	2,480	854	78	105	0.9694	16.16
		7,260	4,520	968				
II	5.5 yrs	2,720	2,210	938				
		3,630	2,870	1,020	63	85	0.9036	11.31
		7,260	5,110	1,099				
III	4.5 yrs	2,720	2,300	571				
		3,630	2,800	601	33	44	1.0000	9.71
		7,260	4,430	683				

In each experiment increasing the numbers of plants harvested per acre has caused significant increases in yield.

In these and in the previous experiment the tea has yet to reach maturity and consequently firm recommendations for the optimum spacing to be used cannot yet be given. It is probable that at maturity the present nearly linear agreements between plants harvested and yield will change into a curve of diminishing returns.

Nitrogen was applied in all these three experiments at 40, 80 or 120 lb. N per acre but no significant differences in yield were obtained from these treatments. There were no significant interactions between spacing and nitrogen rates.

Permanent Shading of Mature Tea

(i) SHADE TREES AND N.P.K.—MIMOSA

In this experiment the effects of three permanent shade trees are compared with unshaded tea and superimposed under each main treatment are the effects of four nitrogen rates with and without phosphate or potash applications. The tea was 7.5 years old at the end of the season and the shade trees a year younger.

All shade tree species have developed sufficiently to offer shade canopies approaching those which may be expected when the trees reach maturity. The tea was clean-pruned at the beginning of the season.

Yield in lb. m.t.p.a. for the past season according to main shade treatments are given in Table XVII.

TABLE XVII

Effect of Shade Trees on Yields in lb. m.t.p.a.

Shade	*Glyricidia*	*Albizzia*	*Grevillea*	*None*	L.S.D.	
Spacing	28 ft. Square	40 ft. Square	40 ft. Square	—	0.05	0.01
Yield m.t.p.a.	1,040	1,093	1,432	1,551	248	390

C.V.%, 5.34

The unshaded tea and that shaded with *Grevillea robusta* significantly outyielded tea shaded with *Albizzia gummifera* or with *Glyricidia maculata*. At P=0.05 there were no significant differences in yield within those pairs of treatments.

It is doubtful if the yield differences are due entirely to simple differences in soil moisture status maintained below each treatment (fig. 2). Moisture movements under *Glyricidia* are not greatly different from those under *Grevillea* or unshaded tea whereas recordings under *Albizzia* indicate that during the season this shade species used more soil moisture than *Glyricidia* (or the other main shade treatments).

It may perhaps be of importance to note that both *Glyricidia* and *Albizzia* now offer a complete dappled shade canopy over virtually all the tea in their plots whereas *Grevillea*, because of its upright growth, still leaves areas of tea which are unshaded throughout the majority of the daylight hours. Unsatisfactory attempts were made on occasions to obtain a quantitative measure of light intensity under the various shade treatments by using Weston exposure meters. Difficulties were obtained from the time involved in taking the measurements with consequent complexities introduced by the sun's changing orbit and, during the rains, cloud movements often made a comparative series of readings impossible.

The most satisfactory set of data indicated that the average light intensities under shade treatments are arranged according to the yield order—the densest shade effect being under *Glyricidia* decreasing under *Albizzia* and *Grevillea* into full light with the unshaded tea. But much remains to be done in developing a reliable method of obtaining light intensities (or some other measure) before a comparison of yield data with shade densities *per se* can be put onto a quantitative basis.

There were no significant effects from fertilizer treatments.

(ii) OBSERVATION PLOTS, SWAZI

Recordings continued to be made under non-replicated plots of mature tea shaded with and without mature *Albizzia gummifera* and young *Grevillea robusta*. Half of each plot receives no fertilizer and the remaining half 80 lb. of nitrogen (N) per acre. At the start of the season the tea was clean-pruned.

Yields for the past season are given in Tables XVIII and XIX.

TABLE XVIII

Yields in lb. m.t.p.a. under Albizzia gummifera shade

	Albizzia		*Mean for Nitrogen*
	Without	*With*	
Without nitrogen	805	825	815
With nitrogen	1,048	878	963
Mean for Shade	926	852	—

In this year following prune the average effect of shade has been to depress yield. Although considerable benefits were obtained from nitrogen with unshaded tea no extra effect was obtained under shade.

Before heavy down-prune four seasons ago, shade was having a consistently beneficial effect equivalent to that obtained from 80 lb. N. per acre on unshaded tea. Following down-prune these consistently large effects have not been maintained. A new pattern is now appearing in that such effects as are obtained are at a minimum immediately following prune and reach a maximum in the last year before prune. It is possible therefore that there is some correlation between the quantity of leaf carried by the bush and shade effects. No more precise detail can be offered as yet.

TABLE XIX

Yields in lb. m.t.p.a. under young Grevillea Shade

	Grevillea		*Mean for Nitrogen*
	Without	*With*	
Without nitrogen	874	1,013	944
With nitrogen	1,345	1,233	1,289
Mean for Shade	1,110	1,123	—

Considered on the average, *Grevillea* has had little effect on yields. As with *Albizzia* the highest yield was obtained from unshaded tea with nitrogen and the response under shade has been depressed.

General Comments on Field Experimental Results

For a number of seasons past, perplexing and what appear to be peculiar results have been obtained from various field experiments. The immediate reaction is that these are brought about by faulty field work or analyses but on checking it is pleasing to report that very rarely do serious mistakes occur because of the rigid routine evolved over the years.

As more and more data is collected it becomes clearer each year that it is unsatisfactory to examine the effects of any single management method. The response(s) in yield are the results of an interplay between the various contrasting field management methods used with tea. For example pruning state and method is now appearing as an essential constituent of the nitrogen response story and of the response to shade picture.

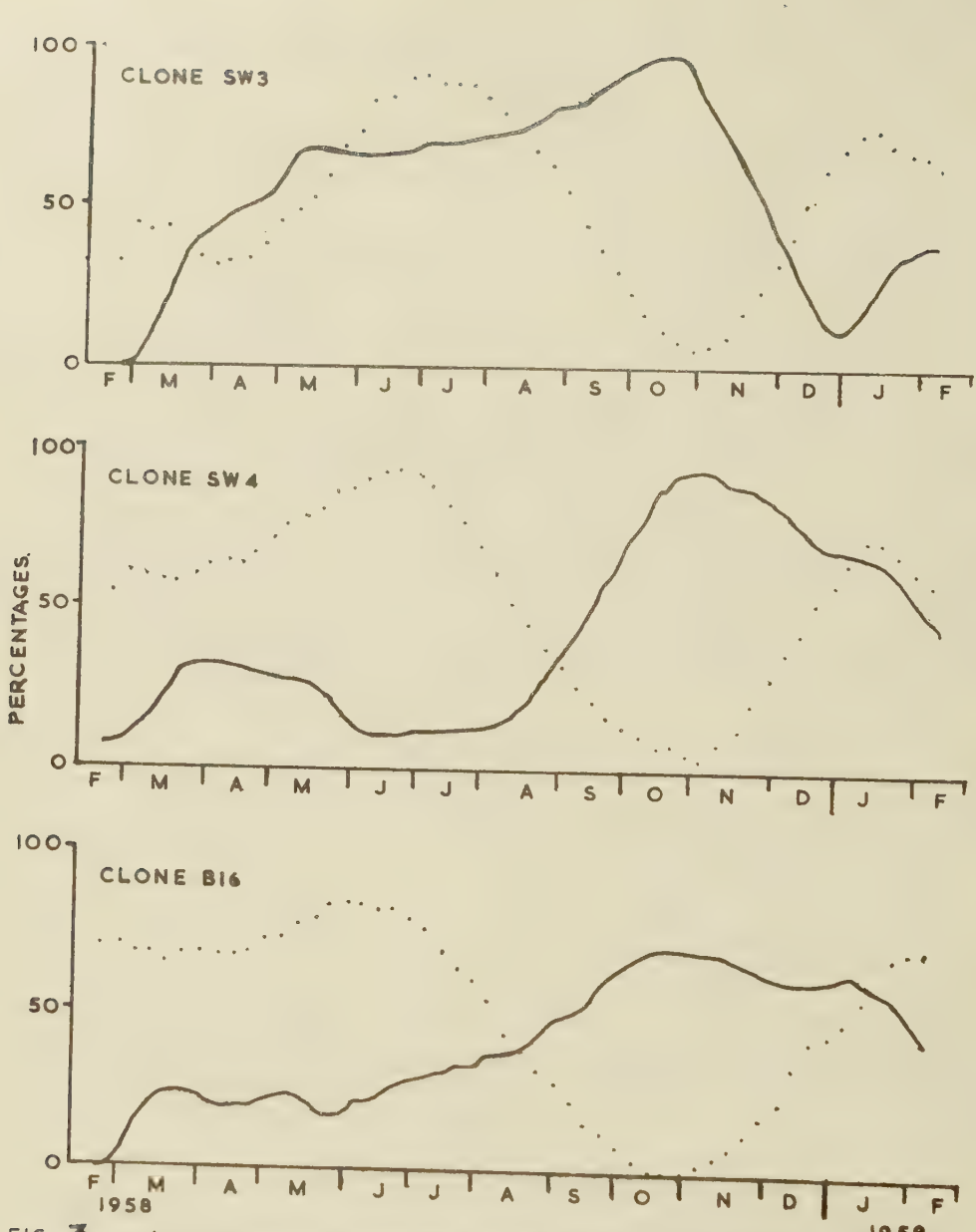

FIG. 3 °/o growing apical buds —— survival of rooted cuttings .....

These various facts are more involved than would appear at first sight because undoubtedly climatic differences within and between seasons are involved to a large extent and in what is expected to be non-linear relationships. The key to the complex story might be found in moisture relationships. It had been hoped during the year to examine these complexities in some detail but this was not possible because of staff shortages.

Until convincing explanations are available it must be constantly borne in mind that the yields and responses reported in this and in past reports, however perplexing they are within and between seasons, are obtained from carefully designed field experiments.

It should also be fully appreciated that tea is a long term perennial spending perhaps forty years of its mature life on one field site. None of the tea in the Mimosa experiments is yet 10 years old and consequently it would be very unwise to formulate long term policies on these early results.

A final example may be given of one perplexing and worrying detail apparent throughout this past season's results. Although rainfall was considerably below average and badly distributed, good crops have been harvested. In good crop years the standard errors of the experiments have usually shown a tendency to fall—but this year they have in fact risen. Field supervision and recording was maintained very much as in previous years and no explanation can be offered.

Vegetative Propagation

(i) THE TIME OF TAKING CUTTINGS IN RELATIONSHIP TO THE BANJHI CYCLE

This experiment, which records the effect of the banjhi cycle at the time of planting on the survival of cuttings, is fully described in paragraph (i) of the Vegetative Propagation section of the Annual Report for 1957/58.

During the year 1958/59, 20 cuttings were taken weekly from each of three clones instead of planting on alternate days as during 1957/58, thus the experiment could be planted continuously throughout the year. The graphs showing the smoothed out data for the banjhi cycle at the time of planting and the percentage survival four months later, are shown in fig. 3; these graphs are in close agreement with those of the previous year's experiment.

(ii) FORMAL FACTORIAL EXPERIMENTS

Previous work on this station indicated the important influence of shade on the survival and rooting of cuttings (A.R. 56/57). These experiments were designed to investigate the shade effect more closely and to compare three clones under the same environmental conditions.

The shade over a cutting influences the transpirational rate and with this in mind the use of a plastic anti-transpirational dip (S600) was included in the treatments.

The experiment was of the three-cubed design, with 50 cuttings per plot, there being two complete replications using green-barked cuttings and one replication using red-barked cuttings.

The treatments were:

(i) An anti-transpirational dip (S600)
a0=nil, cuttings dipped in water.
a1=cuttings dipped for 20 minutes in dilution 1:8 (by vol.) of S600:water.
a2= „ „ „ „ „ „ dilution 1:4 (by vol.)

(ii) Clones: selected from clonal stockbeds at Swazi

b0=Clone SW1
b1=Clone SW6
b2=Clone B10

(iii) Shades of cloth on honeycomb brick walls.

c0=One layer of grey sheeting =25 per cent. full light.
c1=Two layers of grey sheeting = 6.25 per cent. full light.
c2=Three layers of grey sheeting = 1.56 per cent. full light.

Previous work, mentioned in the 1957/58 report, has correlated survival at four months with rooting, so it may be assumed that the recordings of survival summarized below are in all probability records of rooted cuttings. The analysis was done on the angular transformation of the results as most of them fell in the 70–95 per cent. range. The table below is the recorded percentages.

TABLE XX

The Percentage survival of green-barked cuttings 30 weeks after planting

Treatment	*Anti-transpirant*			*Clone*			*Percentage full light*			L.S.D. P		
Level	0	1.8	1.4	SW1	SW6	B10	25.0	6.25	1.56	0.05	0.01	0.001
% Survival	72.7	71.9	74.9	71.8	65.4	82.4	64.4	73.0	82.2	8.5	10.3	15.5

C.V. (for angular transformation) =13.4%

The results given in Table XX show that the heavier shading is beneficial for the rooting of cuttings, and that highly significant variations occur between different clones. There were no significant interactions.

Similar recordings for the red-barked cuttings gave no significant results (P=0.05 level). Although the trend was similar to that in Table XX, it would seem that red-barked cuttings are less affected by the environmental conditions than are green-barked cuttings.

To summarize this experiment:

(*a*) Anti-transpirant dip under the conditions of the experiment seems to have been of little benefit.

(*b*) Clonal differences were significant as can be expected, both with the survival and the shooting results.

(*c*) The effect of shade seems complex. The early effect of the heaviest shade was to increase survival but seemed to depress shoot growth. Shoot growth is usually an indication of root growth so it is thought that the heavy shade probably delays root growth. It is thought that an early heavy shading may lead to a high percentage survival and then a decreased shade may lead to earlier and increased shoot growth and its related root growth, therefore an experiment comparing decreasing amounts of shade was laid down during May, 1959, the results of which will appear in next year's report.

(*d*) As there were no significant interactions in the experiments it seems probable that one technique for propagating will be suited to the majority of clones, excluding inherently shy rooters which for large scale propagation would be discarded during selection.

(*e*) Green-barked cuttings seemed more quickly affected by environmental conditions than did red-barked cuttings although the overall percentage of rooted cuttings was greater with green barked cuttings.

A repetition of this formal experiment was planted during April, 1959, using the same clone and shade treatments but a root inducing substance (hormone) replaced the anti-transpirant dip and the cuttings were a mixture of green and red-barked material.

(iii) THE CORRELATION OF ROOT AND SHOOT GROWTH OF TEA CUTTINGS

The green-barked cuttings from the factorial experiment recorded above were dug up and carefully washed 32 weeks after planting. All shoot growth and root growth was then severed from the original cutting and dried to constant weight, separately.

The dry weights of shoots and roots for two clones (SW6 and B10) were found to be significantly correlated to the level P=0.001; the results of the third clone (SW1) were found to be insignificant.

(iv) FERMENTERS AND NON-FERMENTERS

As mentioned in the 1957/58 report, about 10,000 cuttings from 35 clones, which had been selected by estates as good or bad fermenters, were planted at Mimosa under a woven bamboo lath shade.

Of these cuttings 86.9 per cent. were surviving three months after planting, and after hardening off over 60 per cent. were transplanted to a conventional nursery for further growth and eventually planting on a pilot plot scale.

The majority of propagation experiments previously carried out had used material which had vegetative origin, and the reasonably high percentage of cuttings in this trial which were transplanted indicates that the technique developed is satisfactory on material of seedling origin.

The cuttings in this experiment were planted during April and May, 1958, and were transplanted when the majority of the cuttings had axillary shoots of about four leaflets, which for the majority occurred during October–November, 1958. Some clones which did not develop axillary shoots till March, 1959, remained in the original beds till then but the percentage surviving and transplanted was small, and it is recommended that striking beds be cleared in January and any material still not ready for transplanting be discarded.

During 1958/59 no further cuttings were taken from these selected bushes as all the leaf available was required by the Biochemist for analysis.

Green leaf samples from several bushes and some 50 rooted cuttings were flown to the United Kingdom for use by the Biochemist. The green leaf arrived in good condition but the majority of the cuttings have since died; it is intended to send more rooted and unrooted cuttings.

(v) FIELD SECTIONS: MIMOSA

From 37 bushes, selected for yield, fermentation and apparent drought resistance, a total of 11,000 cuttings were planted under woven bamboo lath shade; of these 24.2 per cent. have been rooted and transplanted to a conventional nursery shade for further growth.

The low percentage rooting of these selected bushes is thought to be caused by the cuttings being planted at a non-optimum time—which owing to lack of space and material at the optimum time was unavoidable.

A further planting of 9,780 cuttings from the same bushes was made during April–May, 1959.

(vi) THE EFFECT OF WOOD AND BUD STATES ON THE SURVIVAL OF CUTTINGS

Recording of wood and bud states have been made over the period of three years; an earlier result is given in para. 117 of the 1956/57 report. Table XXI shows the results for the period July, 1956–June, 1959.

TABLE XXI

The Percentage Survival of Cuttings Four Months after Planting

Axillary bud state	*Wood state*			
	Soft green	*Hard green*	*Red-barked*	*Total*
Dormant	22.8	40.3	45.3	40.4
Swollen	23.3	48.8	46.6	43.8
Elongated	46.7	45.8	42.8	44.1
Removed shoot	—	36.2	31.5	34.6
Flower bud	—	—	42.2	41.3
Total	26.6	44.9	44.0	42.2

The overall percentage survival is low because many of the cuttings were planted at times other than the seasonal and/or banjhi cycle optima.

The low percentage survival of soft green-wood cuttings and where an axillary shoot has been removed may indicate that where material is plentiful neither of these conditions should be planted as cuttings.

It is recommended that any state of axillary bud may be used as cutting material until such a bud has grown enough for a leaflet to be clearly discernable; if this stage has passed the shoots should be left till the lateral shoots may themselves be used as cuttings. It is now thought that where a terminal bud is in the growing state it may be advisable to discard four leaves and a bud and two leaves where the bud is dormant.

(vii) TINGAMERA SEED-BEARERS

A small seed bearer garden of Tingamera seedlings was planted during 1950 but there were only six survivors by 1952, due probably to faulty clearing of the site and the subsequent occurrence of *Armillaria*.

Seedlings from the survivors were planted during 1957 and in May, 1959, 120 cuttings were taken from each of the five remaining original plants.

Air Layering of Tea

Earlier experiments on air layering of tea are described in the 1956/57 annual report, paragraphs 156–167.

Basically air layering is the wounding of a branch to expose the cambial layers and treatment to induce root growth.

In all the following experiments the wound was in the form of a $\frac{1}{2}$-inch girdle of bark being removed to the cambium; various media were contained in polythene sheeting so as to remain in close contact with the wound. All the tea bushes air layered were under heavy natural shade. The results are divided into three grades:

(*a*) Rooted=actual root growth recorded.

(*b*) Callused=callus and/or root initials, but no roots, were recorded.

(*c*) Died=the leaves and buds above the wound dead.

Results were recorded 6 months after the layers were made but it is now considered that inspection 3–4 months after layering is better as the establishment of the layers when left for 6 months was not satisfactory.

(viii) A COMPARISON OF VERMICULITE AND SPHAGNUM MOSS AS A MEDIUM FOR AIR-LAYERING TEA

A medium is needed to retain moisture near the wound but this medium must at the same time be well aerated. The conventional medium, sphagnum moss, is not readily available in Nyasaland so vermiculite, an expanded micaceous product which is more readily available, was used in comparison with sphagnum moss.

Air layers were made monthly over a period of 15 months and over 22 bushes.

TABLE XXII

The Percentage of Rooted and Callused Air Layers comparing Vermiculite and Sphagnum Moss

Treatment	*Number of layers*	*Rooted per cent.*	*Callused per cent.*	*Died per cent.*
Vermiculite	225	0.4	19.1	80.4
Sphagnum Moss	220	47.7	18.6	33.6
Total ..	445	23.8	18.9	57.3

The table shows a result much in favour of sphagnum moss against vermiculite, which may be due to the alkaline nature of the latter; in view of this result it is intended to investigate the possible use of local mosses which are readily available.

(ix) TO RECORD THE INFLUENCE OF THE TERMINAL BUD ON AN AIR LAYER MADE BENEATH IT

It is thought possible that the growth stages of a terminal bud may affect rooting. On the same air layers as in the above experiment the bud state was recorded.

TABLE XXIII

The Effect of Terminal Bud State on Air Layers Made Beneath It

Bud State	*Air Layers Made*	*Rooted per cent.*	*Callused per cent.*	*Died per cent.*
Dormant	141	29.0	19.1	53.9
Growing	304	22.4	18.75	58.8
TOTAL ..	445	23.8	18.9	57.3

From Table XXIII the terminal bud state would seem to have little influence over air layers, which is in contradiction to the findings of the 1956/57 experiment, therefore further trials are to be made.

(x) TO RECORD THE EFFECT OF SEASON, BANJHI CYCLE AND CLONE ON AIR LAYER

The air layers recorded above were made at monthly intervals and the results were related to seasons and banjhi cycle records.

The results have shown no record of seasonal effect but there is an indication that banjhi cycle may affect air layers in much the same way as it does cuttings.

A clonal influence was recorded, as with cuttings, and cuttings from the bushes air layered were planted; an indication given was that a clone which is reluctant to produce roots in an air layer is likely to be a shy rooter from cuttings.

The results are inadequate to be more than a slight indication and for this reason details are not published; it is hoped to carry out more detailed study of this topic.

Sundry Notes

(*a*) A bulletin was published during the year being " The Vegetative Propagation of Tea " which summarizes briefly the findings of the work done on this station and is intended as a guide for planters who wish to begin selection and vegetative propagation work. Copies of the bulletin are obtainable on request to this station.

(*b*) The plant laboratory has been re-erected on Swazi Station and has been in use for several months.

(*c*) A Mist Propagation Unit has been set up and the preliminary trials for continuous and intermittent mist are well in hand; the first experiment should be planted during September, 1959.

(*d*) Rooted cuttings transplanted to polythene tubes have produced roots to a depth of 18 inches and have been planted out at field spaces. The weather has been adverse for such a trial and results are not yet completed but the success is not expected to be high. It is intended to plant cuttings direct into polythene tubes.

Plant Breeding and Selection

All work on these subjects, except a small selection programme at Swazi, has been held in abeyance awaiting the appointment of a Plant Breeder.

Blue Gum (Eucalyptus spp.) Experiments

A simple experiment of randomized blocks was laid down to compare the effects of nitrogen and dieldrin on young blue gums.

The blue gum seedlings, about three months old, were transplanted from nursery beds to the field during December, 1957, using a Herschall planter, and deaths were supplied a week later.

The treatments were:

1. Nitrogen at 30 lb. per acre as sulphate of ammonia.
2. As 1 plus 3 lb. per acre (active ingredient) of dieldrin.
3. 3 lb. (a.i.) dieldrin per acre mixed in sand as a filler.
4. 3 lb. (a.i.) dieldrin per acre mixed in aqueous solution.
5. Untreated control.

Treatments 1 and 2 were applied in two equal applications three weeks and eight weeks after planting, treatments 3 and 4 were applied on planting.

Records of survival were made during December, 1958.

TABLE XXIV

Effect of Nitrogen and Dieldrin in the Percentage Survival of Blue Gums

Treatment	30 *lbs* N	*N+Dieldrin*	*Dieldrin in sand*	*Dieldrin in water*	*Control*	L.S.D. 0.05	L.S.D. 0.01
% Survival plot means ..	44.0	67.5	80.0	80.0	74.5	17.8	26.3

C.V. = 50%

The figures at Table XXIV show a significantly reduced survival caused by the application of nitrogen. Unfortunately the experiment was not recorded to show increases of growth in survivors, but it is thought that the nitrogen increased growth rate which lead to softer growth which in turn was more liable to death than the harder growth from the untreated control. With this in mind a further experiment, of better design, was laid down during February, 1959, but results are not as yet available.

There was no significant benefit by using dieldrin except where mixed with sulphate of ammonia, but it should be remembered that an experiment of this nature tends to reduce the overall termite population of the whole area covered by the experiment and thereby affords some protection to the untreated plots.

The methods of applying dieldrin caused no effect on survival.

Biochemistry of Tea Fermentation

by D. S. Bendall

Department of Biochemistry, University of Cambridge

Many chemical changes occur during the manufacture of black tea. The most obvious is the development of brown pigments which eventually impart the characteristic colour to a tea liquor. Other important changes are (*a*) the breakdown of the green colouring matter (chlorophyll) of the fresh leaf, (*b*) the production of aroma, and (*c*) the breakdown of so-called pectic substances.

The development of brown colour is due to the aerobic oxidation of polyphenolic substances occurring in the leaf. This reaction would proceed very slowly but for the fact that the leaf also contains an enzyme which hastens the reaction. A living leaf contains many different enzymes each of which is specific for a different chemical reaction; the enzyme which is responsible for the oxidation of polyphenols is know as polyphenol oxidase. In the living leaf the polyphenols occur in the vacuole, which is separated by a thin membrane from the cytoplasm of the cell in which the enzymes occur. The oxidation of the polyphenols is initiated during rolling by damage to this membrane with consequent mixing of the cell contents and bringing together of the polyphenols and the oxidase.

The term fermentation is most often used to indicate anaerobic processes which are due to the activities of bacteria or fungi such as in brewing or wine-making. Clearly it is used in a very different sense in tea manufacture. It is often taken to mean simply the enzyme oxidation of polyphenols, but in a wider sense it may be used to include any chemical change which is initiated by rolling and due to the activity of enzymes (or ferments) in the leaf.

The present research into the nature and mechanism of the chemical reactions occurring during tea fermentation has been undertaken in the hope that a chemical method of influencing these reactions which would lead to an improvement in quality

of Nyasaland tea, will be found. Research during 1958–59 has concentrated on the production of colour in fermenting leaf and on the properties of the polyphenol oxidase system. The breakdown of chlorophyll has also been investigated because of the importance which is attached to the appearance of the infused leaf.

The first step was to develop methods for assessing the rate of production of brown pigments, which for simplicity will be referred to subsequently as the rate of fermentation.

As qualitative methods for determining the rate of fermentation the chloroform and mincing tests were examined by repeated tests on two series of bushes. Appreciable variability in the results was observed; on the one hand individual first leaves from the same bush gave variable results in the chloroform test, and on the other neither test always gave the same result on different occasions. However, provided that suitable precautions were taken in performing the tests, and more than one test was made on each bush, the two methods could be used to classify fermentation of individual bushes as poor, medium or good. In general the two methods gave the same result, and there was little to choose between them in reliability, but occasionally they differed seriously. About two hundred bushes in nine different rows on eight estates in both Cholo and Mlanje have been tested more than once. Of these approximately 60 per cent. were medium, about 20 per cent. were poor and only 10 per cent. were good.

A quantitative method for measurement of the rate of fermentation was developed, which depends on the complete extraction of the pigments of a fermented leaf, followed by their separation on the one hand into the brown oxidized polyphenols and in the other into chlorophyll pigments. Both classes of pigment in the same samples of leaf could thus be analysed by measurement of the colour intensity in a spectrophotometer.

Analytical methods were also developed for the estimation of total content of polyphenols and of polyphenol oxidase activity. The nature of the mixture of polyphenolic substances present in green leaf was resolved by two-dimensional paper chromatography as described by Roberts.

The methods are not yet entirely satisfactory, but they were sufficiently accurate for use in the analysis of a series of selected bushes. The purpose of these measurements was to determine the factors responsible for poor fermentation.

Weekly samples of pluckings from selected bushes were sent by Dr. Cutting and Mr. Scarborough from Nyasaland to Cambridge by air. In most cases the leaves arrived in fair condition but sometimes extensive browning had occurred.

Analyses on twenty different bushes showed that both rate of fermentation and polyphenol oxidase activity varied over at least a three-fold range, and that there was a significant correlation ($P < 0.01$) between the two. Neither total polyphenol content nor variations in the relative amounts of different polyphenols were significantly correlated with rate of fermentation. The important conclusion was therefore reached that the main cause of poor rate of fermentation is low enzyme activity. Nevertheless the possible importance of total content and nature of polyphenols will not be neglected. Brightness of liquor and infused leaf is clearly an important factor which depends partly on care during manufacture, but it is probably also influenced by factors in the leaf itself. The oxidation of the polyphenols during manufacture follows a rather complex series of reactions and the concentration of polyphenol may influence the course of these reactions, and hence brightness. Furthermore a relatively low total polyphenol content probably means that a less intense colour can be produced before brightness is lost by over-fermentation.

The change in concentration of total chlorophyll pigments during fermentation was measured on samples from fourteen different bushes. The changes observed

were small, being sometimes a decrease and sometimes an increase. It is probable that in fact no extensive breakdown of chlorophyll occurred and that the variations observed were mainly due to sampling errors. However quite a small change in the chlorophyll molecule causes a very marked change in colour from green almost to brown. Chlorophyll is a complex organic molecule with an atom of magnesium at the centre. Removal of magnesium (for example by acid) converts it into the brownish compound, phaeophytin. This change would not have been detected in the present experiments because an acid solution was used to extract the pigments from the leaf. Conversion of chlorophyll to phaeophytin may be an important change during tea manufacture, which may occur during firing rather than during fermentation.

The results described above indicate some of the major lines of research which will be followed in future. Clearly it is important that the polyphenol oxidase should be purified, its properties studied, and factors which influence its activity in the leaf investigated. It is important that any improvement in colour should maintain or increase brightness, and work on a method for measuring brightness is in progress. The possible conversion of chlorophyll to phaeophytin will also be investigated, and this will require methods for the determination of chlorophyll and phaeophytin independently. Extensive research into the effects of different nutrient conditions on clonal bushes may well help to solve the fermentation problem.

SUMMARY

1. Methods were developed for the measurement of (*a*) rate of fermentation, (*b*) polyphenol oxidase activity, (*c*) total polyphenol concentration and (*d*) concentration of total chlorophyll pigments.

2. These methods were used to determine the cause of poor fermentation in samples sent by air from selected bushes in Nyasaland to Cambridge.

3. The main cause of poor rate of fermentation is low polyphenol oxidase activity. Polyphenol content appeared to be less important but may influence brightness of liquor.

4. No change in total chlorophyll pigments could be detected during fermentation. The appearance of the infused leaf might be noticeably influenced by a small change in the chlorophyll molecule which would not have been detected in these experiments.

5. The main line of future research will be the purification of the polyphenol oxidase and a study of its properties and of factors which influence its activity in the leaf. Brightness of liquor and changes in the chlorophyll molecule will also be investigated.

TABLE XXV

Meteorological Record 1958/59 at Mimosa Tea Research Station, Mlanje

Month	*Rain ins*	*Rainy days*	*Running total*	10 *year mean*	*Mean monthly max. °F*	10 *year mean*	*Mean monthly min. °F*	10 *year mean*	*Hours sun*	5 *year mean*
July, 1958 ..	1.32	5	1.32	1.41	71.5	74.6	52.0	52.3	202	201
August ..	2.58	10	3.90	1.64	74.6	78.4	54.7	53.0	186	216
September ..	4.72	5	8.62	1.19	84.3	84.4	60.6	56.4	239	217
October ..	1.60	5	10.22	2.52	87.3	90.0	63.2	61.9	124	251
November ..	3.47	9	13.69	7.07	89.2	88.3	66.2	65.2	245	212
December ..	7.26	13	20.95	10.73	87.9	85.8	66.6	66.2	225	167
January, 1959	9.03	14	29.98	13.60	85.9	84.0	65.2	66.1	215	172
February ..	11.43	19	41.41	11.03	82.2	84.0	67.4	66.2	105	154
March ..	14.59	15	56.00	11.46	82.9	82.7	64.2	64.6	224	179
April ..	0.82	4	56.82	5.24	83.6	82.0	61.6	61.8	254	211
May ..	0.15	3	56.97	2.48	85.6	78.4	57.1	56.1	280	222
June ..	1.24	4	58.21	1.97	77.2	74.0	54.3	52.7	204	158
TOTAL ..	58.21	106	58.21	70.34	—	—	—	—	2,502	2,360

TUNG

1. Production of Improved Planting Material

The nineteen-year-old experiment at Bvumbwe continues. Yields have been maintained, *montana* buddings having produced in 1959 a mean of 1,798 lb. of dry nuts per acre.

At Bvumbwe the two other clonal trials and a collection of legitimate seedling families are maintained should there be a revival of the industry (see the 1957/58 Part II Report). Two estates also maintain clonal trials which are not yet in full bearing, one in Northern Province and the other in Southern Province.

2. Fertilizer Trials

Experiments on young trees on estates comparing the effect of sulphate of ammonia with equivalent amounts of tung cake have been discontinued after four years. The table below shows that sulphate of ammonia is superior to tung cake when applied at equivalent rates of nitrogen (4 lb. sulphate of ammonia approximately equals 20 lb. of tung cake). Tung cake has no beneficial cumulative effect. The results also show that there is no advantage in splitting the applications at Gala or Nchima. Neither does there appear to be any loss in applying the fertilizer in July either as one dressing or as part of a split dressing; at Nchima there was a significant increase shown by applying the 4 lb. rate in July.

TABLE I

Nitrogen Fertilizer Trial on Young Trees, lb. dry nuts

	Control	*Tung Cake lb./tree*		*Sulphate of Ammonia lb./tree*					L.S.D.
	0	20	30	2	4	4*	6	6*	P=0.01
Gala (8 *yrs. old*) Total yield per tree, 4 years ..	30.8	29.8	37.8	36.8	48.6	51.7	40.9	40.3	6.3
Mean yield per year, 1956–58 ..	7.7	7.5	9.5	9.2	12.2	12.9	10.3	10.1	1.6
Converted to mean yield per acre ..	432	417	529	515	680	724	573	564	88
Nchima (6 *yrs. old*) Yield per tree, 1959	9.0	14.2	16.6	22.2	19.4	27.3	21.1	21.8	10.5 (5%)
Total yield per tree, 4 years ..	19.3	28.6	32.7	40.6	42.5	51.7	41.4	40.6	8.5
Mean yield per year, 1956–59 ..	4.8	7.2	8.2	10.2	10.6	12.9	10.4	10.1	2.1
Converted to mean yield per acre ..	271	400	458	569	595	724	579	568	119

*Applications made as follows:
Gala—split applications in October and December.
Nchima—4 lb. applied in July.
6 lb. applied as split applications in July and October.
All other applications were made in late October to early November.
Coefficient of Variation, 25.4 per cent. for Gala; 40 per cent. for Nchima which is high due to 1959 being a significantly higher yielding year than the three preceding years.
There was no interaction between treatments and years.

Two other fertilizer experiments are being recorded. The NPK CuZn factorial at Bvumbwe continues to show a significant response to nitrogen only as in previous years. The NPK factorial at Mzuzu is now showing a small response to phosphate as well as nitrogen (see table below).

TABLE II

NPK Trial at Mzuzu

Yield dry nuts per acre

Treatment	*Sulphate of Ammonia*				*Mean*
	N_0	N_1	N_2	N_3	
	Nil	65 lb.	195 lb.	390 lb.	
Superphosphate					
P_0 nil lb.	2590	5454	5005	7548	5149
P_1 65 ,, ...	4805	5434	6947	6797	5996
P_2 130 ,, ...	2507	4589	4456	5163	4179
P_3 195 ,, ...	3534	6003	4084	7202	5206
Mean	3309	5370	5123	6678	

L.S.D. P. 0.05 = 1074 lb.

Coefficient of Variation, 29.2 per cent

Extract from Report of the Agricultural Chemist, Bvumbwe

1. STATUTORY ANALYSIS OF EXPORTED OIL

Sales of the 1957–58 crop reflected a depressed market position, at the end of which price was only £65–£70 f.o.b. Beira. Due to this fall in price, some estates did not send all their seed to the factory and this led to slight overselling of the crop. The total exports were thus only 846 tons, the distribution being 390 tons to U.K., with 65 elsewhere in Europe, 101 tons (including 12 tons *fordii*) to South Africa, 10 tons to East Africa, 250 tons to U.S.A., and 30 tons to Japan. The current crop (1958–59) is almost completely sold, as prices have recovered considerably (about £120 f.o.b.), due to the absence of exports from China.

2. COMPOSITION OF TUNG OIL

The chemical constants are generally similar, except the main one of heat test, which as indicated in last year's report, was high at all places, being particularly so in the Zomba area. In the current crop now being expressed, the Southern Province oils have returned to their normal figure of 23–26 minutes, and the Vipya oil is still at 26. Regarding the latter, it has been seen that due to the clones involved or climatic effects, the figure of 26 minutes is such that it allows little latitute for increased acidity over 1 per cent. The polymerization time has exceeded that specified, although the acidity was well within specification.

Several batches of Southern Province seed which had been inadequately stored, were examined on behalf of the factories, and the acidity of the oil found to be up to 20 per cent., and due to the poor market position they were rejected.

3. TUNG OIL UTILIZATION

With the poorer market position, the possibility of extended use of *montana* tung oil in specified fields was investigated, and reports have been requested from the Overseas Products Laboratory, and a private consultant who has specialized in paint materials and products, these to provide later guidance than given in similar surveys made in 1952–54. It appears that the most promising development might be in the field of those manufacturers whose smaller production or specialist products would enable them to switch over completely to the *montana* type of oil. In this connection it is interesting to note that one South African user, who is now using only *montana* oil, refused the offer of *fordii* oil when this was made to them.

COFFEE

1. Cultivation and Manurial Trials

Reference has been made in previous reports to three latin square experiments designed to establish whether coffee should be grown with shade and/or mulch. Of these only the one located at Bvumbwe was recorded this year. The Gala experiment yielded no crop having not yet been thrown out of its biennial bearing cycle following an incorrect pruning treatment. The Namingomba experiment had to be abandoned because of vacancies caused by *Fusarium* disease. The Bvumbwe experiment, planted in December, 1953, yielded its third crop which was a record one.

TABLE I

Shade/Mulch Experiment, Bvumbwe, 1959

Layout 4×4 Latin Square, 36 trees per plot.
Main treatments, see table below.
N.P.K. factorial with four replications superimposed on plots split to four nine-tree sub-plots.

Treatments	*Yield Clean Coffee lb. per acre*
M. No shade, mulched with napier	1960
S.M. Albizzia shade, mulched with napier	963
(1) Grevillia shade, mulched with napier*	661
S. Albizzia shade, mulched with tung hulls*	482
L.S.D. P=0.01	269
0.05	179
Coefficient of variation	10.2%

* (1) and S not mulched for the first three and two years respectively. Temporary shade of bananas in (1) and of *Sesbania* in S and SM for first three years.

Yields were high this year and there were very significant differences between treatments. The results underline the fact that coffee, once subjected to an unfavourable treatment during the period in which it is establishing itself, is adversely affected throughout the whole of its first cycle of bearing. The unfavourable treatments, *Sesbania* shade in the S and SM plots, banana shade in the (1) plot and lack of mulch in (1) and S were rectified three to four years ago, yet the mulched, unshaded plot (M) still yielded in 1959 a very significantly heavier crop than all others. As *Albizzia* alone has not produced such an adverse effect on coffee in another experiment running alongside, the big difference between M and SM can be attributed in the main to the lasting effect of the *Sesbania*. Similarly the difference between S and SM is due to the lack of mulch in S in the past rather than the difference between the mulching materials now; this deduction is supported by the fact that the two originally unmulched treatments (1) and S are still the worst.

In order to gauge what effect must be due to the permanent shade trees, *Albizzia* and *Grevillia*, soil moisture samples have been taken over two seasons in this experiment and the table below shows that the unshaded, mulched coffee (M) has access to significantly more soil moisture in the dry months September to November, than coffee interplanted with shade trees.

TABLE II

Inches Available Water Present to Depth of Seven Feet under Mulched Coffee

Treatment	1958			1959			
	June	*Sept.*	*Nov.*	*June*	*July*	*Sept.*	*Mean*
SM. *Albizzia* shade ..	8.23	6.15	5.00	11.33	6.04	3.81	6.76
(1). *Grevillia* shade ..	10.92	7.64	5.03	9.77	7.63	3.42	7.40
M. No shade	10.85	10.78	7.77	12.72	7.90	5.45	9.25

L.S.D. between means of treatments P=0.005–1.27. C.V. 5.0%

Where these shade trees compete critically with coffee for moisture has yet to be shown. In another trial there was no evidence to show that competition by *Albizzia* was critical (*see* table below).

TABLE III

Effect of Albizzia as a Shade tree

Treatment	*Mean Yield, Clean Coffee (cwt. per acre)*	*Dieback count after harvest*
Albizzia shade	12.4	6.04
No shade	12.6	10.89
L.S.D. P=0.05	Not Sig. C.V. 34%	4.39

There were no significant differences in yield to suggest that *Albizzia* shade had influenced the crop in any way. The shade was apparently not yet dense enough to reduce flower bud formation. After the crop was stripped, a count was made of shoots which had died back; the fact that dieback was greatest where there was no shade, suggests that *Albizzia* was not competing unduly with the coffee.

In addition to napier grass and tung hulls as mulching material, sawdust was also used in one experiment at Bvumbwe where it is readily available. Trees two years in the field and not yet in bearing looked yellower with a sawdust mulch than with a grass mulch in mid-September, well into the dry season. But as soil moisture was greatest under sawdust, it can only be assumed to be a temporary shortage of nitrogen. Analysis of leaf samples for nitrogen showed no difference between either although the figures were marginal.

TABLE IV

Soil Moisture in Two-year Old Coffee

Mulch	*Percentage Moisture*		
	9″ deep	*18″ deep*	*36″ deep*
Napier Grass	9.80	12.63	13.69
Sawdust	10.68	13.56	15.33

The sawdust is quickly incorporated in the soil and tends to leave a surface cap. There was no significant difference in growth in the first year between coffee grown with the two types of mulch but in the following year trees with a grass mulch yielded 10.88 cwt. per acre and with sawdust mulch 9.98 cwt. (L.S.D. at P=0.05 being 0.74).

The usual response to nitrogen in the shade/mulch experiment at Bvumbwe was not apparent this year and there was no significant response to any of the fertilizers N, P and K or interaction between the fertilizers and main treatments. This is further reinforced by a chemical analysis of leaves for sulphur. Leaves from plots which had received no fertilizer contained between 310 and 450 p.p.m. of sulphur whereas those which had been fertilized with sulphate of ammonia contained between 330 and 360 p.p.m. There is little difference in the level and it may be considered that there is no deficiency of this element. (Normal tea contains 300–400 p.p.m. of sulphur and sulphur-deficient tea 30 p.p.m.)

The cherry/clean coffee outturn in this experiment was 5.38:1 which is lower than last year. The percentage of Grade A coffee was 84.3, Antestia damage having been controlled more effectively.

The manurial/pruning trial at Nchenachena has suffered many losses from *Fusarium* disease and was uprooted after the crop had been recorded. A response to dung was still to be detected.

A third manurial trial, at Katoto in the Misuku hills, has shown no response because it is located in an exposed area; coffee sheltered with grass fences produced much healthier foliage. It will be recalled that this phenomenon occurred last year when symptoms of zinc deficiency were allayed not only by spraying with zinc but most markedly by providing shelter; zinc deficiency symptoms are commonly observed where the rate of metabolism is low. Thus shelter is a further essential requirement of coffee and it is becoming standard practice to plant all boundaries with a double line of pines and to break up plantations into blocks of not more than four acres in size with a single line of grevillias and a double line of bananas.

A further aspect of the manurial response of coffee was noted at Mzuzu where growth of trees fertilized with tung cake was poorer and foliage yellower than where equivalent amounts of sulphate of ammonia had been used. A parallel may be drawn with the tung experiment detailed elsewhere in this report where the nitrogen of tung cake appears to be less readily available than that of sulphate of ammonia.

2. Variety Trials

An experiment planted at Bvumbwe in 1955/56 bore its first crop. Object—to compare twenty-six imported selections with a local variety. Layout—Randomized block with 8 plots.

The trees had made good growth and were pruned in October, 1958, to a 3 feet 6 inches head. Yields and dieback after cropping were recorded (*see* table below).

TABLE V

Coffee Variety Trial, Bvumbwe, 1959

Yield, cwt. per acre

Variety	*Clean Coffee*	*Mbuni*	*Mean Dieback*	*Variety*	*Clean Coffee*	*Mbuni*	*Mean Dieback*
SL28 ..	17.18	2.21	5.5	Blue Mountain ..	10.73	1.26	13.1
SL34 ..	14.12	2.96	4.2	Geisha	10.24	0.72	6.7
SL14 ..	13.79	1.52	6.5	Kent's	9.47	1.31	4.1
KP162 ..	13.00	2.50	5.1	KP228	9.40	2.14	3.0
KP423 ..	12.82	1.30	6.0	Dilla and Alghe ..	8.88	1.23	5.0
N81 ..	12.72	3.68	23.8	K7	8.79	1.54	13.2
KP128 ..	12.39	2.92	12.1	N5	8.68	2.63	7.6
N39 ..	11.89	2.77	14.8	Ke20	8.40	3.53	13.6
N197 ..	11.83	2.13	9.6	SL6	8.09	3.66	5.3
H66 ..	11.28	2.89	15.4	Local	8.02	0.49	6.0
I60 ..	11.28	1.61	12.5	Mocha	7.88	1.47	8.0
K.S.A. ..	11.03	2.01	14.6	Maragogipe ..	7.38	1.24	9.6
H133 ..	10.88	2.20	19.0	L1	5.85	2.07	4.2
				Dalle Mixed ..	3.21	2.28	0.8

L.S.D. mean yields, P=0.01—3.39

The three most recommended Kenya selections SL28, SL34 and SL14 head the list of high yielders and the local selection was a comparatively low yielder. But these yields are, on the average, too high; the bearing head allowed was too large and overcropping resulted in most varieties; harvesting was spread over the period 28th May to 11th August, 1959, by which time the remaining crop had to be stripped and turned into mbuni. Where overcropping occurred, the mbuni figures are high, as in the varieties N81, Ke20, SL34, KP128 and H66.

A further sign of overcropping was dieback of primaries, a count of which was made after harvest. Dieback can also occur after defoliation resulting from leaf miner attacks.

Leaf miner attacks were least on lightly shaded coffee (a score of 3.56 against 4.63 with a 1 per cent. significant difference of 0.62 which can be compared with the dieback counts in Table III) and varieties differed in their susceptibility. The heavy-yielding large-leaved varieties SL14, SL28, SL34 and K.S.A. and the Tanganyikan Bourbon selection N81 were most severely affected whilst the small-leaved but well-foliated low-yielding varieties, Geisha, N5, Dilla-and-Alghe and Dalle-Mixed were least affected; outstanding amongst those least affected by leaf miner is KP228, a variety which was chosen for the shade/mulch experiment. From observations at Bvumbwe and at other centres, it is evident that a fairly strict control of leaf miner will be necessary.

The observation plots of Tanganyikan selections at Bvumbwe have borne their third crop which was exceptionally high as were all yields this year.

TABLE VI

Observation Plot at Bvumbwe

Selection	*Yield clean coffee (lb. acre)*
N81	2498
N39	2178
N197	1794
L1	1754
Brazil	1640
H66	1615
N5	1044
KP423	812
KP162	698

These trees have now been pruned for conversion to the second cycle.

The variety trial at Cholo has been decimated by *Fusarium*, no single variety showing any marked resistance to the disease. In this area, wetter and warmer than Bvumbwe, the most promising selections have been Ke20 and SL6 from Kenya and N5, N39 and N197 from Tanganyika.

The formal variety trial at Gala is progressing satisfactorily and two other trials have been planted at Mzuzu and Mwera Hill.

No firm recommendations as to variety can be made at this stage. Each coffee-growing locality will in a few years have an opportunity to select its own variety since 26 microplot trials were planted this season; a wide selection of varieties was planted over a range of altitudes. It was a poor planting season and varieties have shown much variability in establishment; thus N197, for example, has been outstandingly satisfactory whereas SL14 and SL19 have suffered many vacancies.

Fifteen more microplot trials are due to be planted next season.

The record of N197, N5, Brazil and KP228 has been good enough over the last three years to recommend for planting on a restricted scale. SL28 and SL14, once established, promise well among the Kenya selections at Bvumbwe and Nchenachena.

3. Age of Planting Material

Coffee seedlings are usually planted at the age of 15–18 months. As it has been claimed by growers that they can obtain as good or even better stand by planting twelve-month old seedlings instead of 15–18 month old plants, a trial was planted in December, 1958 at Bvumbwe to compare the value of planting both types, (*a*) bare-rooted and (*b*) roots balled in soil.

Layout—2^2 Factorial with six replicates, each plot of 20 trees containing sub-plots of four varieties, H66, N81, N197 and Brazil. The first phase of the experiment was to compare the planting survival of the various treatments.

Results—It was a poor planting season, a series of long dry spells occurring during the period of establishment. Vacancies were counted at the end of January.

TABLE VII

Vacancies in Age of Planting Material Trial

Treatment	*Vacancies per plot*	*Percentage per plot*
Balled Roots, 15–18 months	Nil	Nil
Balled Roots, 12 months	0.17	0.85
Bare Roots, 12 months	1.67	8.35
Bare Roots, 15–18 months	5.50	27.50
L.S.D. P=0.05	2.73	—
Coefficient of Variation	117%	—

The conventional method of planting 15–18 month old bare roots, was in this instance the worst. It is usual for not more than 3.5 per cent. vacancies to occur with this method. The success of the 15–18 months old, balled-root plants suggests that it might be a profitable proposition to grow nursery plants in polythene sleeve pots. Against the success of the 12-month old plants has to be weighed the fact that the plants were not as advanced and an additional cost is incurred in field operations before the plants can come into bearing, the second phase of the experiment will investigate this aspect further. The experiment will also be repeated in 1960.

4. Coffee Under Tung

A series of observation plots of coffee have been planted under tung at Bvumbwe with the object of showing whether this is a practicable proposition to supplement the tung growers' income. As coffee does not grow well under the heavy canopy of a fully planted tung plantation, there are three population densities of tung and the coffee will be grown on both multiple and single stem systems.

5. Moisture Requirements of Coffee

In addition to the work reported under paragraph 1, an experiment was initiated in 1959 at Bvumbwe to assess the effect of irrigation at various times of the year in relation to different stages of growth of the crop.

Treatments—1. Control, no irrigation,

2. Irrigate maturing crop only,
3. Irrigate during flowering period only,
4. Combination of 2 and 3,
5. Irrigate monthly as required.

Soil moisture samples are taken regularly and a continuous check is maintained with the aid of gypsum blocks inserted to the depth of ten feet. A root system was washed out and coffee six years in the field had penetrated to a depth of seven feet. These samples are used to calculate the amount of water to be applied, the available soil moisture not being allowed to fall below $\frac{3}{4}$ field capacity.

6. Vegetative Propagation

A preliminary study was made at Bvumbwe of the vegetative propagation of coffee. The conventional brick-sided glass lights were used and a broken shade provided protection from sun scorch.

Treatments

1. *Propagation media.* Six media were employed.

    1. Leaf mould/sand/red soil in proportion 7:5:2 by volume.
    2. Leaf mould/coarse sand, 1:1.
    3. Red soil/coarse sand, 1:1.
    4. Vermiculite/sand, 1:1.
    5. Coarse river sand.
    6. Vermiculite.

    Approximate acidity values of the various media were as follows:
    1.—7.0, 2.—6.5, 3.—6.0, 4, 5 and 6.—5.5.

2. *Rooting Hormone.* Three rooting hormones were used.

    1. Control—dipped in distilled water for 14–18 hours.
    2. Phyomone.
    3. Seradix B—moist cuttings dipped in powder.
    4. Planofix.

Phyomone and Planofix contain α-naphthyl acetic acid and α-naphthalene acetic acid respectively and were made up according to the makers' instructions; the cuttings were dipped in the solution for 14–18 hours.

3. *Type of cutting.* Three types of cuttings were prepared.

    1. Two to three nodes, 4–5" long.
    2. 1 node, cut at internodes.
    3. As for 2 but split longitudinally to make two one-leaved cuttings.

Firm semi-ripe, green, woody cuttings were taken from plants on which sucker production had been induced.

Results

Root formation was well under way within two months and the cuttings were inspected and potted up 3½ months after inserting. The results are shown in the table below.

TABLE VIII

Percentage Cuttings Rooted

1. *Rooting medium*	*Number of cuttings planted*	*Percentage rooted*
Leaf mould/sand	82	78.3
Red soil/sand	77	68.5
Leaf mould/sand/red soil	100	56.0
Sand	71	47.7
Vermiculite	66	21.3
Vermiculite/sand	70	15.3
L.S.D. P=0.01	—	8.2

2. *Type of Cutting*	%	3. *Hormone*	%
Single node	56.7	Phyomone	66.5
2/3 nodes	43.7	Water	56.9
Single node, split	43.0	Seradix B-2	51.8
		Planofix	16.0
No significant difference	—	L.S.D. P=0.01	4.0

The leaf mould/sand mixture resulted in a significantly greater percentage of takes over all other media, the figure of 78.3 being of all types of cuttings and hormone treatments rooted in that medium. Red soil and sand was also a fairly satisfactory

rooting medium but lifting was difficult, root breakages frequently occurring. Vermiculite did not encourage root growth; root initials, once formed, would fail to develop and roots, once developed, would grow slowly and even die back.

Although the advantage of the single node cutting over other types of cutting is not significant, it has the added advantage over the 2/3 node type in that more cuttings can be produced from the same material.

Phyomone was the only rooting hormone which resulted in significantly better rooting than water; rooting was induced over a large portion of the stem. Planofix was too strong at the strength used and cuttings were damaged. There was no significant interaction between the type of cutting and the hormone used.

Of those cuttings which rooted, root formation was greatest in the leaf mould/sand mixture both in length of the longest root (17.3 cm.) and the number of roots over 1 cm. produced (7.7). Sand also produced a larger number of roots but root growth was weak and some dieback occurred.

TABLE IX

Performance of Rooted Cuttings

Rooting medium	*Mean length of Roots (cm.)*	*Mean Number of Roots*
Leaf mould/sand/soil	12.9	6.4
Leaf mould/sand	17.3	7.7
Soil/sand	13.6	6.5
Vermiculite/sand	4.9	2.8
Sand	6.0	7.9
Vermiculite	3.0	2.9
L.S.D. P=0.01	4.5	
Type of Cutting	*Mean length of Roots (cm.)*	*Mean Number of Roots*
2/3 node	11.8	9.4
Single node	11.2	6.8
Single node, split	8.4	2.4
L.S.D. P=0.05	2.1	
Hormone		
Water	13.0	4.7
Phyomone	10.9	6.0
Seradix	12.7	8.0
Planofix	4.1	5.1
L.S.D. P=0.05	3.47	—

The biggest cuttings produced the longest and greatest number of roots, the split cuttings being significantly the worst. Seradix produced the greatest number of roots.

The general conclusion to infer from these results is that a leaf mould/sand mixture is very satisfactory; Phyomone assists rooting in the early stages but does not influence the length or amount of root produced subsequently; Seradix, although not as good as Phyomone for general rooting, does increase the number of roots produced.

A single node cutting is preferred. Split cuttings could be used where propagating material is in short supply but the length and number of roots produced is less.

7. Fusarium Dieback Disease

A plant pathologist has arrived to study the problem of *Fusarium* dieback disease in coffee and a laboratory is in the course of construction. An area of coffee, just coming into bearing, has been laid out to a fungicidal spraying trial; no results can be reported at this stage. The incidence of *Fusarium* is invariably high where coffee has been subjected to a strong limiting factor in its growth; examples are excessive shade or weed competition, inadequate mulching, overcropping and inadequate protection from the wind.

PUBLICATIONS

" Coffee-Growing Prospects in Nyasaland " by L. J. Foster.
Nyasaland Farmer and Forester 4 (4), June, 1959.

" Fusarium Bark Disease of Coffee in Nyasaland " by D. C. M. Corbett.
Nyasaland Farmer and Forester 4 (4), June, 1959.

FRUIT AND VEGETABLES

1. Banana Manurial Trial

A 3×3×2 N.K.P. manurial factorial was planted at Bvumbwe in 1959 with the local variety " Kabuthu ", a dwarf Canary type of banana at the request of the Cholo African Fruit Growers Association. Results will be published in next year's report. In the period before fruiting there was a marked response to nitrogen, as shown by leaf colour and growth.

2. Strawberries

The experiment planted at Bvumbwe in 1957 to study the manurial and irrigation requirements of strawberries and described in last year's report was concluded in 1959.

Layout—2^4 factorial with two replications. Plots consisted of two double rows 18 inches apart separated from each other by a space of three feet. Plots were split to contain two easily identifiable and high-yielding varieties, Melba and Cambridge 449, each subplot comprising twenty plants at a spacing of 18 inches. The plant population was 15,488 to the acre.

Manurial Treatments—nitrogen (N), 200 lb. per acre sulphate of ammonia applied in split dressings, half in early April and half in August,

—phosphate (P), 400 lb. per acre single superphosphate at time of planting,

—potash (K), 50 lb. per acre muriate of potash in April.

Irrigation Treatments—Rates of water per application were as follows:

I_1—1957—$\frac{1}{3}$ acre inch
1958—$\frac{1}{2}$ acre inch
I_2—1957/8 $\frac{2}{3}$ acre inch.

A non-irrigated treatment I_0 was represented by a series of side plots outside the experiment.

Electrical soil moisture gauges were used to determine irrigation times and study water utilization.

The results may be summarized as follows:

(i) Growth and yields due to the higher irrigation level were significantly greater than all other treatments (*see* Tables I and II).

TABLE I

Growth made by Strawberries in First Eight Months, 1957

(*mean spread in decimetres*)

	Control	*N.*	*P.*	*NP.*	L.S.D.
Low irrigation I_1 ..	2.34	2.32	2.43	2.47	0.21 (P=0.05)
High irrigation I_2 ..	2.60	2.77	2.70	2.90	0.29 (P=0.01)

Coefficient of variation =13.6%

TABLE II

Yield, 1957 (short tons per acre)

	Control	*N.*	*P.*	*NP.*	L.S.D.
I_1 ($\frac{1}{3}$ acre inch) ..	3.67	4.00	4.18	4.13	0.63 (P=0.05)
I_2 ($\frac{2}{3}$ acre inch) ..	4.68	5.28	5.48	5.48	0.87 (P=0.01)

Coefficient of variation =10.6%

When the lower irrigation I_1 was increased to $\frac{1}{2}$ acre inch, the advantage of I was lost.

TABLE III

Yield, 1958 (short tons per acre)

	Control	*N.*	*P.*	*NP.*	L.S.D.
I_1 ($\frac{1}{2}$ acre inch)	2.53	2.53	2.54	2.84	Not
I_2 ($\frac{2}{3}$ acre inch)	2.29	2.73	2.81	2.67	Significant

(ii) Small responses were obtained to nitrogen and phosphate in the first year but only in the presence of adequate moisture (*see* Tables I and II). This can probably be attributed to the fact that dunging prior to planting provided most of the nutrient needs. There was no significant response to fertilizers in the second year.

(iii) C.449 was a better cropper than Melba (*see* Table IV).

TABLE IV

Yield of Varieties, short tons per acre

	C.449	*Melba*	*Mean*	L.S.D. (P=0.01)
1957	4.42	2.98	3.70	0.29
1958	3.31	1.91	2.61	0.36

(iv) A high plant population is recommended. The plant population (15,488 to the acre) was lower than in the variety trials (25,813) which were running alongside this experiment. The yield was correspondingly lower thus justifying a closer spacing.

TABLE V

Yields and Plant Population, 1957

(*plants in their first year*)

Spacing in rows	*C.449*	*Melba*
9″	5.75	4.11
18″	4.42	2.98

(v) It is not recommended that strawberry beds be allowed to crop for more than one year (*see* Table IV).

(vi) In areas of a prolonged dry season frequent irrigation of strawberries is necessary. A grower would have to budget for at least one inch of water per week.

Some fruit was damaged by soil pests and disfigured by rain and irrigation water splash. Part of a 1959 planting of C449 was therefore covered overall one month after planting by polythene sheeting, the plants being passed through slots made in the sheeting. The polythene sheeting resulted in a 60 per cent. increase in yield; the percentage of disfigured fruit was reduced from 34.8 to 12.8.

PUBLICATIONS

"Trial of Strawberry Varieties in Nyasaland," L. J. Foster. *Rhod. Agric. Journal* 55 (5), Sept./Oct., 1958.

"Further Aspects of Strawberry Culture in Nyasaland," by L. J. Foster and R. A. Wood. *Rhod. Agric. Journal* 56 (5), Sept./Oct., 1959.

3. Pineapples

A pineapple variety trial was planted in March, 1957, at Bvumbwe at the request of the Cholo African Fruit Growers Association.

Layout.—Two 3×3 latin squares with double rows 20 inches apart at 5′ between centres. Plots of two double rows.

Varieties—1. Smooth Cayenne or Kew Pine at 18 inches apart,
2. Hawaiian Queen at 12 inches apart,
3. Local Queen at 12 inches apart.

Fertilizers—plots split to compare no fertilizer with sulphate of ammonia at 600 lb. per acre in two split dressings, half in December/January and half at the end of May. All plots received 400 lb. per acre of superphosphate at the time of planting.

The plants were irrigated occasionally.

Results—Cropping started in February, 1958, but did not reach any proportions until January, 1959.

Pineapples, Yield, short tons per acre, 1958/59

	Yield per acre	*Mean size of fruit (lb.)*
Smooth Cayenne	9.31	2.28
Hawaiian Queen	1.27	1.57
Local Queen	0.93	0.92
L.S.D. P=0.01	5.44	—
Coefficient of variation	57%	—

The yield of Smooth Cayenne was reasonable but of the two Queen varieties was far below an economic level. The size of Smooth Cayenne fruit was also greater; the strain of Hawaiian Queen fruit imported was of a very poor type, basal shoots adhering to the fruit itself. Nitrogen gave a 46 per cent. increase in yield (see table below).

Response to nitrogen (all varieties)

Treatment	*Yield per acre (short tons)*
No Fertilizer	2.61
Nitrogen	4.79
L.S.D. P=0.01	2.09

There was no interaction between fertilizer and varieties.

An analysis was made of the leaves as an indication of nitrogen uptake.

Composition of Pineapple Leaf Samples

	Variety	*N.*	*P.*	*K.*	*Ratio K/P*
No fertilizer	Smooth Cayenne	1.04	0.21	0.97	4.7
	Hawaiian Queen	1.04	0.17	1.52	9.0
	Local Queen	0.84	0.19	1.10	5.8
N-fertilizer	Smooth Cayenne	1.26	0.21	1.16	5.6
	Hawaiian Queen	0.93	0.15	1.16	7.8
	Local Queen	1.00	0.19	1.32	6.9

The K/P ratio is lower than the figure of 12–14 suggested from Malaya (Leaf Analysis in Relation to Yield and Quality of Pineapples by K. Kamapathy, *Malaya Agric. Journal* 41 (1), 1958) the potash content being on the low side but well above the figure of 0.4 per cent. regarded as minimum. It would appear therefore that an application of potash may be profitable and the fertilizer treatment has been varied accordingly for the first ratoon crop.

4. Tomatoes

Two trials were planted at Bvumbwe with the puree tomato variety San Marzano. One was a time of planting trial, four sowings being made monthly from January to April inclusive; recording has not yet been completed and the results will be reported next year. The other was a manurial trial with plants sown at the end of January for planting at the end of February and cropping at the end of the rains.

Layout—Randomized Block, 6 plots.

Plants spaced 2′ apart in rows 2 feet 6 inches apart and staked.

Treatments—(1)—No fertilizer,
N.—163 lb. per acre, sulphate of ammonia,
P.—180 lb. per acre, single superphosphate,
K.—57 lb. per acre, muriate of potash,
NP—N + P as above
NK—N + K as above
NPK—N + P + K as above, i.e. complete 6 :6 :6 fertilizer at 400 lb. per acre.
S—Sustanum 6 :6 :6 fertilizer at 200 lb. per acre.

It was claimed that Sustanum, because it released its fertilizer slowly, could be used at half the rate of the conventional inorganic fertlizer.

Results—Plots which had not received nitrogen looked yellower than the others a month after planting out.

Cropping extended for 6 weeks from 23rd May to 6th July and yields were higher than in a previous experiment in spite of the fact that there was some loss of fruit due to attacks of late blight (*Phytophthora infestans*). In order to keep the experiment going, it was necessary to spray every 7–10 days from 23rd March to 7th June with a captan/dithane mixture. Two irrigations were made in March and April—but this may not have been sufficient because in the first two weeks of the cropping period 63 per cent. of the fruit had to be discarded due to blossom end rot. For the remainder of the period 85 per cent. of the fruit harvested was of good quality.

Tomatoes, Yield, short tons per acre

(1)	*K*	*S*	*P*	*NK*	*N*	*NP*	*NPK*	L.S.D.	
								P=0.05	P=0.01
13.4	11.8	13.6	14.4	15.8	16.3	16.4	16.6	2.3	3.1

Coefficient of variation = 13.4%

The results show that there is no advantage to be gained by fertilizing with potash but significant increases in yield are obtained from nitrogen. Sustanum gives no increase in yield at the rate applied and its extra expense cannot therefore be justified.

5. Onions

Two trials were planted at Bvumbwe. One was a time of planting/variety trial with the varieties Texas Grano, Early Cape, De Wildt and Bombay Red. The other was an NPK manurial trial with the variety De Wildt. Lack of supervision of these experiments during the Emergency led to very poor yields which did not exceed 3½ tons per acre. In the manurial trial a response was detected to nitrogen only at the 5 per cent. level and De Wildt was the highest yielding variety. Several D.D.T. sprayings had to be made against thrips.

6. Other Observations

Records continue to be maintained of deciduous and sub-tropical fruit trees at Bvumbwe, Mwera Hill and Nchenachena. Considerably higher yields of deciduous fruits, peaches and plums in particular are obtained at Nchenachena where irrigation provides no problem. Winter temperatures are too high at Bvumbwe for deciduous fruits and trouble is experienced yearly with bud fall-out of peaches in the winter and flowering is not prolific.

Improved germination of quinine peach seed, which is used as a stock for budding named varieties of peaches and plums, was obtained by storing in the refrigerator for three weeks.

NCHENACHENA

Variety		*No. of trees*	*Mean tree yield in lb.*		
			1958	1959	*Mean*
Peach	Angel	5	88	34	46 (7 years)
	Killiecrankie	5	28	60	69 (7 years)
	Waldo	5	208	88	146 (7 years)
Guava	Red budded	5	57	(1) ?	70 (7 years)
	Red seedling	5	59	?	94 (6 years)
	Patnagola	1	120	64	—
	Parkers White	3	50	?	—
Plum	Santa Rosa	3	13	45	31 (4 years)
	Satsuma	5	30	173	69 (4 years)

(1) Although harvested the trees were not fully recorded during the Emergency.

Extract from Report of the Agricultural Chemist, Bvumbwe

CITRUS

The fertilizer experiment at Neno has been continued, and though yields were inconclusive, for it will take a season or so for the trees to become completely vigorous again, the appearance of the trees receiving nitrogen was much improved. The fruit was larger, and the incidence of brown skin was less. At the end of the fruiting period, it was found that on those trees where no fertilizer had been used, the nitrogen in the leaf was only 0.7 per cent., compared with 1.6 per cent. in the leaf from trees treated with cattle manure, and 2.6 per cent., where ammonium sulphate had been applied. This data together with the fact that chlorosis and dieback was clearly increasing rapidly, caused the Mission to decide to apply fertilizer. In view of the vast improvement and increased yields, they are continuing its use this year. The past year was however a good season for citrus anyway, and so the results of a further season are awaited with interest.

It is also interesting to note that the copper and zinc contents have also assumed a normal figure, at 8 p.p.m. and 17 p.p.m. respectively. Yields have increased and the problem now seems to be converted to one of marketing.

PINEAPPLES

Leaves from 3 varieties of pineapples from Bvumbwe were examined to assess their need for potash in addition to N. Based on K/P ratios, reported from Hawaii and Malaya, these would seem to require K fertilizers—but on a basis of K content they would appear satisfactory. The low K/P ratios may be due to the much higher P status of our soils.

CACAO

In connection with establishment trials of cacao, several interesting points were investigated.

1. *Potassium deficiency.* At Makanga Station, symptoms of necrosis which resulted in collapse of the interveinal areas, leaving a fine leaf network, were reported. The erection of hessian shelter round a few trees, had led to growth of normal fully green leaf. Analysis of normal and affected leaves showed them to be of similar composition except for potassium, which was 1.4 per cent. and 0.8 per cent. respectively, the potassium/calcium ratio being also significantly different at 1.0 and 0.4 respectively. This was most surprising in view of the fact that the exchangeable soil potassium in this area is more than 1.0 m.g.e./100 gm. Although when in bearing, cacao is a heavy consumer of potash, these plants were only 18 months old. The leaf damage was similar to that previously noted on young tung suffering from nitrogen deficiency, i.e. where weak leaves are involved. From the effect of hessian it appeared also that a shelter aspect was involved. Further investigations and advice showed that the potash deficiency was due to the very heavy banana shade being used throughout the plot. This has consequently been thinned, and the shelter belt intensified. So far no changes have been noted in leaf composition, but this may take some time to become effective.

2. *"Sickle" Leaf.* At the Khureya plot in the Mlanje District, the cacao was much behind that at Makanga, being only 18 inches tall after 18 months. They showed evidence of sickle leaf, which has been associated elsewhere with zinc deficiency. The plants had received appreciable quantities of ammonium sulphate—and it was thought that this might have had an adverse effect, the pH of the soil being 4.6, although this was not greatly different from the usual soil of this area (5.1), this latter figure in any case being rather low for cacao. Leaf samples were analysed and compared with satisfactory leaf from the tea station, as shown in the following data.

	Khureya "Sickle" leaf	*Tea Station satisfactory leaf*
N%	2.27	2.22
P%	.13	.17
K%	1.22	1.11
Ca%	.75	.48
Mg%	.31	.39
Total Ash%	8.60	7.70
Aluminium p.p.m.	680	445
Copper ,, ...	8.80	7.60
Iron ,, ...	332	188
Manganese ,, ...	730	313
Zinc ,, ...	36.80	27.00

The higher content of zinc is also rather surprising, since sickle leaf has been associated with contents of less than 6 p.p.m. in data reported from Ceylon, the satisfactory leaf containing 20 p.p.m. It is also seen that the zinc content is the same as that in the leaf from plants growing in the Tea Station nursery. Even here, it was significant that plants at the end of the row in the nursery, i.e. slightly more exposed, were showing some signs of chlorosis and malformation. As Mr. Urqhuart was most insistent that cacao should be completely free from wind, it seems that this is the main cause of the sickle leaf, some support for this being seen in the better growth on the bottom terrace—which had some measure of protection by a row of bananas.

The effect of shelter or absence of it already noted on the incidence of zinc deficiency in coffee, would appear to be equally important with cacao. It may be noted that the zinc content of leaf from the vigorous plants at Makanga was 35–45 p.p.m.

IRRIGATION

The Shire Valley Project

The Elephant Marsh, an area of some 160 square miles lying between Chiromo and Chikwawa along the Shire River, has been further surveyed to investigate the possibility of reclaiming and irrigating part of the area by means of a polder. The report of the consultants, NEDECO of Holland, is expected before the end of 1959. Such a scheme would provide considerable additional acreage for cotton growing in the Lower River; about 25,000 acres are planted at present.

Crops and Yields

Table I should be read in conjection with Table IV of last year's report, and summarizes the results for 1958/59.

TABLE I

Comparative Value of Irrigated Crops

Crop	*Acres*	*Yield/acre*	*Value*	*Value/acre*
Dry Season 1958				
Linseed	.36	768 lb.	1s per lb.	£38
Wheat	2.0	796 lb.	3d per lb.	£10
Maize	1.0	2,871 lb.	1d per lb.	£12
Red Beans	.87	597 lb.	£30 per ton	£8
Beetroot	.10	13.5 tons	£8 per ton	£108
Carrots	.10	24.3 tons	£8 per ton	£194
Onions	1.0	9.6 tons	3d per lb.	£240
Potatoes	.07	4.8 tons	3d per lb.	£120
Lucerne Meal	.91	2.5 tons	£20 per ton	£50
Sugar	.60	2.2 tons (estimated)	£50 per ton	£110
Wet season 1958/59				
Cotton	3.0	1,900 lb.	6d per lb.	£49
	—	222 lb.	2d per lb.	
Maize	2.0	3,646 lb.	1d per lb.	£15
Groundnuts	2.0	890 lb.	4d per lb.	£15

Crop Water Requirements

MEASUREMENT OF EVAPORATION

Since the installation of the meteorological station some 15 years ago, the trees in the vicinity have grown considerably. It is suspected that the evaporation as measured by the open pan is being underestimated; comparable piche evaporimeters in the irrigation area are giving readings some 15 per cent. higher. These will be continued, and the Water Development Department have supplied a second evaporation pan which has been installed in a more open site. Both pans were painted black inside in October, 1959, in accordance with the recommendations of the 3rd Hydrology Conference at Kampala in August, 1959. A cup anemometer was installed at the new site in September, 1959.

Until more data are available, irrigation factors continue to be based on the original evaporation pan readings.

Over 26 months, the evaporation recorded by the open pan in inches per month and the piche evaporimeters exposed in the open in ccs. per month are related as follows:

$$E_0 = 2.47 + .01907 \text{ Epiche } (r^2 = .8806)$$

LEAF AREA MEASUREMENTS

Leaf area curves for crops grown in the 1958 dry season and the 1958/59 wet season do not differ appreciably from those shown in last year's report.

SOIL MOISTURE

Regular readings using gypsum blocks and the Bouyoucos meter were taken under an irrigated maize crop in the 1958 dry season. An attempt to correlate these readings with direct determinations of soil moisture using the drying oven has only emphasized the irregularity of the soil profile at Makanga. An alluvial soil, it contains layers of sand at varying depths in the predominantly silty loam. Available moisture in the silty loam probably lies between 35 per cent. (field capacity) and 18 per cent. (wilting point), while in the sandy layers it lies between 16 per cent. and 5 per cent.

Irrigation Experiments

Six formal irrigation experiments were carried out according to the design illustrated in Fig. 6 of last year's report; all treatments were watered according to the leaf area index, making an allowance for evaporation from bare soil, until the particular treatment index (=irrigation factor) was reached; this factor was then applied for the rest of the period of the experiment.

TABLE II

Irrigation Factors and Yields

Irrigation Factor	*Jan./Dec.* 1958	*Dry Season* 1958			*Wet Season* 1958/59	
	Lucerne Hay tons/acre	*Wheat grain lb./acre*	*Shelled Maize lb./acre*	*Shelled Beans lb./acre*	*Seed Cotton lb./acre*	*Shelled Groundnuts lb./acre*
.4	4.24	—	—	450	2,227	—
.6	4.79	1,268	2,986	500	2,228	1,106
.8	5.60	1,237	2,869	636	2,383	1,173
1.0	6.81	1,010	2,947	646	2,006	1,053
1.2	6.87	1,044	3,109	—	—	1,050
1.4	—	—	—	—	—	942
1.5	—	—	—	770	—	—
1.6	—	860	3,237	—	—	—
2.0	—	683	3,081	578	—	—
2.4	—	—	2,852	—	—	—
3.0	—	827	—	—	—	—
S.E. ..	±.150	±173.6	±118.9	±49.6	±151.4	±39.2
Sign. Diff. ..	.45	N.S.	357	149	N.S.	N.S.
C. of Var. ..	6%	30%	7%	17%	12%	9%
Replications ..	5	3	3	4	6	6
Planted ..	12–6–57	29–4–58	2–6–58	23–7–58	18–11–58 30–12–58	16–12–58

Plot Size 1/27.5 acres throughout.

The results of these experiments are presented in Table II. Lack of response to irrigation may mean that the lowest irrigation rate already supplies adequate moisture, as in the wet season trials; or that a deficiency is being made up from available soil moisture reserves, as in the case of maize. Some of the crops are discussed in more detail below.

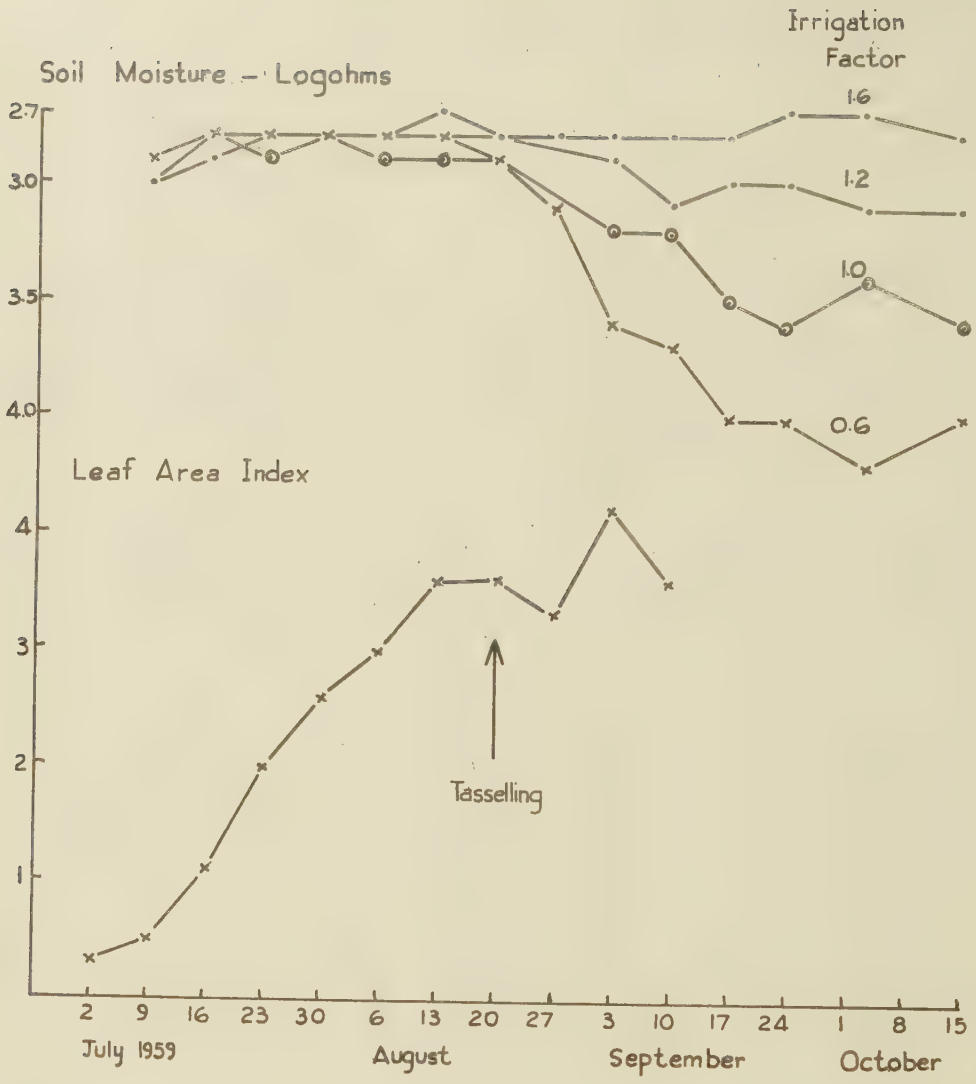

FIGURE 1

Soil Moisture, Irrigation, and Leaf Area of Maize

Soil moisture in logohms is the mean of 3 plots and 3 gypsum blocks placed at 1 ft., 2 ft. and 4 ft. depths in each. Leaf area was measured in plots irrigated at a factor of 2.4. Planted 2nd June; yields shown in Table 7.

COTTON

No irrigation treatment deliberately applied has so far produced any increase in cotton yields at Makanga; a number of treatments have reduced yields, and it seems that too much water is being supplied at some stages of growth. Grown in the wet season because a close season is necessary to limit red bollworm, it is difficult to maintain control of the water supply. Covering plots with plastic sheeting proved unsatisfactory because it was lifted and damaged by wind when the cotton was small.

Nevertheless, the good yields in the 1958/59 season indicate that adequate moisture in January and February (prior to and during boll setting) is important; irrigation after the end of March appeared to reduce yields in 1957/58. Preplanting irrigation on observation plots also appeared to reduce yields, and evidence from other crops indicates that it may be better to plant dry and build up soil moisture as the crop develops. These indications will be followed up in the 1959/60 season.

Soil block readings taken during the growing season under the cotton crop in Field L were not reliable, but it is probable that all plots reached field capacity about the middle of January. Blocks were installed at 1, 2, and 4 foot depths in each plot. Irrigation was stopped after 10th March, and by the beginning of June all treatments had dried out to 4 feet, probably nearly to 6 feet according to soil moisture samples taken later.

One other point deserves attention: it was noticeable that the three irrigation fields planted to cotton gave yields of over 2,000 lb./acre of seed cotton, while the fields which were not cropped in the dry season gave around 1,600 lb./acre at best. It seems unlikely that this was due to better soil moisture reserves (see above), and in some cases no irrigation was given after planting. It is suggested tentatively that dry season irrigation may have altered the nitrogen status of the soil.

MAIZE

Trial 8/28 in Field L showed no significant differences in yield between different irrigation factors ranging from 0.6 to 2.0 times the open pan evaporation. Soil block readings however showed that the maize at the lower irrigation rates was drawing on soil moisture reserves.

The leaf area index reached a maximum of 4.0 at the time of tasselling, ten weeks after planting (Fig. 1). In spite of this increase in leaf area, an irrigation factor of 0.6 was sufficient to maintain the soil at field capacity down to 4 feet. During the four weeks after the tassels emerged, however, a factor of 1.6 or more was needed; with less irrigation the maize was removing available water from the soil. From the 14th week onwards, all factors were sufficient to maintain soil moisture; it is difficult to understand why the higher factors did not show any replenishment of the reserves.

This pattern of water use is being studied further in the 1959 dry season.

LUCERNE

Trial 7/18 continued to show that the best yields were obtained with an irrigation factor of 1.0 to 1.2; a similar trial, 8/24, has been established with factors covering the range 0.8 to 1.6.

WHEAT

In trial 8/25 it was confirmed that the best yields of wheat were obtained with a factor of 0.6 or less. It was noticeable that with the higher water rates grasses, notably *Panicum maximum*, appeared above the crop just after flowering, and competed vigorously with the wheat.

VEGETABLES

Eight unreplicated plots were each planted with three kinds of vegetables—onions, carrots, and beetroot. These plots were irrigated at different rates, factors ranging from 0.6 to 3.0. Although the results are not very conclusive, they indicate considerable differences in response to irrigation.

SUMMARY

Irrigation requirements of the various crops tested at Makanga during the past two years are summarized below. Some of these figures are tentative, and there appears to be much more to learn about requirements at different stages of growth.

Crop	*Irrigation factor* (Et/Eo)
Cotton	0.5 probably more in Jan./Feb.
Maize	0.6, 1.6 at tasselling.
Wheat	0.4
Beans	1.5
Onions	(1.0)
Carrots	(0.6)
Beetroot	(1.2)
Lucerne	1.0 to 1.2
Groundnuts	0.8

REPORT OF THE AGRICULTURAL CHEMIST, CHITEDZE

Chemistry Section

All work from this section with the exception of that on soil nitrates, has either been incorporated into the main body of the report or will be found as extracts appended to the various crops concerned.

SEASONAL CHANGES IN SOIL NITRATE STATUS

Monthly profile sampling throughout the year to follow changes in soil nitrate content taking place in cropped and bare fallow plots, has been carried out at Chitedze. The results from two treatments on adjacent plots are presented in Table II.

From these results the following observations can be made:

The effect of a cover crop on soil nitrate status is very marked. It obviously reduces the concentration of nitrate present by taking up what it requires for growth. Also the crop will provide root residues and excretions, and organic material on which the microbial population of the soil will develop. The nitrogen required for microbial growth will be absorbed from the soil as nitrate, so that it could be expected that the nitrate content under a crop will show a rapid falling off during the growing season, and this is demonstrated quite clearly.

Under bare fallow however, conditions allow for a seasonal release of nitrate in the manner suggested by Birch, and the results show that this is considerable after the long dry season experienced in Nyasaland. They further show that unless immediate advantage is taken of this release, i.e. by planting early, the nitrate is quite rapidly leached down the profile where it accumulates at depth, though even here it is gradually removed by drainage.

It would also appear that the previous crop treatment considerably affects the amount of nitrate made available at the onset of the rains as shown in Table I below.

TABLE I

The Effect of Various Crop Treatments on Soil Nitrate Release

Treatment 57/58 season	*(P.P.M.) NO_3 released in top 9 in. at onset of rains*
Bare Fallow	225
After Groundnuts	170
After Maize	141
After Teff	94

This can probably be attributed to the quantity of organic residues remaining in the soil after these treatments at the end of the dry season and the amount of nitrate required by the microbial population in order to break them down.

TABLE II

Soil Nitrate changes in Profiles under Crop and Bare Fallow

Bare Fallow—C Zero

Depth. (inches)	*October* 1958		*December* 1958		*January* 1959		*March* 1959		*April* 1959		*August* 1959	
	per cent. moisture	NO_3 *p.p.m.*	*per cent. moisture*	NO_3 *p.p.m.*	*per cent. moisture*	NO_3 *p.p.m.*	*per cent. moisture*	NO_3 *p.p.m.*	*per cent. moisture*	NO_3 *p.p.m.*	*per cent. moisture*	NO_3 *p.p.m.*
0–4	6.0	47	14.0	226	16.2	12	9.5	21	7.7	58	3.7	78
4–9	11.1	20	15.1	224	17.6	37	14.6	36	12.3	22	9.2	39
9–18	12.4	20	13.5	58	17.5	164	16.4	62	14.8	78	11.3	37
18–30	12.5	22	11.2	31	17.8	118	15.8	134	14.7	86	13.6	135
30–42	12.9	57	12.6	32	17.8	115	16.3	174	14.9	142	14.4	74
42–54	14.2	108	13.5	149	17.4	177	17.0	234	14.9	176	14.5	107
54–66	14.2	112	14.4	192	16.7	194	16.9	258	15.2	198	15.3	139
66–78	15.0	121	15.6	242	—	—	17.3	204	—	—	15.0	109

Maize after Teff Grass C Zero

Depth (inches)	*October* 1958		*December* 1958		*January* 1959		*March* 1959		*April* 1959		*August* 1959	
	per cent. moisture	NO_3 *p.p.m.*	*per cent. moisture*	NO_3 *p.p.m.*	*per cent. moisture*	NO_3 *p.p.m.*	*per cent. moisture*	NO_3 *p.p.m.*	*per cent. moisture*	NO_3 *p.p.m.*	*per cent. moisture*	NO_3 *p.p.m.*
0–4	5.2	32	13.5	91	16.3	14	8.7	3	9.7	5	2.4	10
4–9	10.3	17	14.7	97	17.2	31	13.7	4	12.0	2	9.3	15
9–18	11.6	26	15.3	44	17.2	69	15.2	2	13.4	7	10.5	39
18–30	11.7	72	11.2	46	15.8	—	15.2	7	13.1	5	13.1	—
30–42	12.3	64	11.8	87	13.8	52	15.0	7	12.8	5	13.9	15
42–54	13.1	51	12.6	56	14.6	37	16.0	42	13.0	15	14.8	16
54–66	15.1	17	14.8	24	15.8	22	16.2	43	14.5	24	15.2	20
66–78	15.6	30	15.8	33	—	—	17.2	45	—	—	12.3	27

SOIL PHYSICS SECTION

Water Use Studies at Chitedze

Investigations in progress for the past four seasons comparing the water use of veral annual crops grown in various rotations with that removed by fallows kept re, sown with protective grass cover (*Eragrostis abyssinica*) and allowed to re-nerate volunteer weeds and grasses, have now been concluded. Available water s been plotted from data provided by gypsum electrical resistance blocks initially stalled under the various treatments and quantitative changes in soil moisture ve been measured by soil sampling throughout the profiles at regular intervals, the formation so obtained being converted to inches of water per foot.

Marked variations in water use between the different treatments have been noted ring this period and their effects on moisture utilization and storage to a depth of t. are shown in Tables II and III. More detailed discussion of some of these results s already been given in the Part II Annual Reports for 1956/57 and 1957/58.

Root washing studies on mature crops and grasses carried out during the past ason have clearly demonstrated that a great deal of this variation can be directly ated to the density and type of root system developed. They explain why the digenous vegetation (volunteer cover) has removed more available water than any the growing crops, as it is largely composed of grasses many of which are extremely ep rooting and can trap moisture supplies at depth, thus accounting for the fact that any of them remain green and continue growing long into the dry season. Average oting depth of a variety of pasture grasses grown at Chitedze was shown to be tween 10 to 12 feet.

If it were not for the fact that most of Nyasaland is fortunate in having a well tributed wet season rainfall enabling losses of available soil moisture to be quickly plenished once the rains commence, the drying out of the soil profile to wilting point considerable depths by the indigenous grasses during the dry season could exert very harmful effect on the following season's annual crops. This has been amply monstrated in the semi-arid areas of Tanganyika where rainfall distribution is often ry erratic.

Agricultural Meteorology

This extremely important aspect of soil physics work has received somewhat more ention during the last season. To assist in predicting the amount of water used crops, particularly with regard to their irrigation requirements, it is essential that ne simple and accurate device for determining the amount of solar energy reaching e earth's surface is available, so measuring the amount of heat a crop receives daily m the sun. This is the most important factor controlling the amount of water a p will take from a moist soil. To enable this determination to be carried out ibrated radiation integrators recently developed in East Africa have been installed Chitedze, and will be installed at other stations, together with the American Class A pe evaporation pan.

Other Stations

Work at these stations, namely, Bvumbwe, Mimosa, Swazi and Makanga, has ainly centred on crops requiring dry season irrigation and the section has been tively engaged in devising methods for estimating the amount of water various ops are using at different stages of their growth. Knowing the depth of rooting a particular crop and the quantity of available water the soil can hold within this

depth, it is possible to calculate the rate at which the crop exhausts the water and the rainfall replenishes it. From this we hope to determine the period when crop growth is being limited by water shortage and irrigate accordingly. The moisture characteristics of the soils where these investigations are taking place compared with those of the Chitedze soils are given in Table IV.

The effects of different types of shade treees grown with tea and coffee, in competing for water that would otherwise be available for crop use, are also being studied experimentally with the aid of gypsum blocks and soil moisture sampling. That the effect can be considerable is shown in Table I below.

TABLE I

Ins. water held in 0 10 ft. profile under coffee shade treatments at the end of the 1958 dry season (Bvumbwe)

Albizzia (mulch)	*Grevillea (mulch)*	*No Shade (mulch)*
37.2	37.8	42.0

Further details of the work in progress will be found elsewhere in the report under the crops concerned.

TABLE III

Maximum Seasonal Changes in Soil Water Storage—Chitedze

(*Inches of water in* 6 *ft. soil*)

	Rotation	*Year*	*Wettest Soil Condition*	*End of dry season*
1.	Groundnuts	1956	—	16.04
	Maize	1957	20.71	14.52
	Maize	1958	21.43	13.68
	Volunteer Cover	1959	18.83	13.20
2.	Tobacco	1956	—	14.98
	Tobacco	1957	21.76	14.40
	Maize	1958	20.98	12.83
	Groundnuts	1959	21.39	14.46
3.	Maize	1956	—	14.26
	Groundnuts	1957	22.23	14.52
	Maize	1958	20.42	12.59
	Teff	1959	21.73	13.54
4.	Bare Fallow	1956	—	14.03
	Bare Fallow	1957	20.27	14.22
	Bare Fallow	1958	20.47	14.98
	Bare Fallow	1959	21.14	14.79
5.	Teff	1956	—	12.95
	Teff	1957	21.14	12.52
	Teff	1958	20.37	14.27
	Maize	1959	18.45	12.34
6.	Volunteer Cover	1956	—	12.22
	Volunteer Cover	1957	22.52	12.83
	Maize	1958	21.11	12.88
	Tobacco	1959	21.91	14.72

TABLE II

Comparison of Moisture Storage and Utilization Effects under various Crop and Fallow Treatments at the end of the 1956–1959 Wet Seasons

	GN	*M*	*M*	*V.C.*	*To*	*To*	*M*	*GN*	*M*	*GN*	*M*	*TF*	*Bare Fallow*				*Teff*			*M*	*V.C.*	*V.C.*	*M*	*To*
Measurements	1956	1957	1958	1959	1956	1957	1958	1959	1956	1957	1958	1959	1956	1957	1958	1959	1956	1957	1958	1959	1956	1957	1958	1959
Ins. available water remaining under each 0 3 ft. profile ..	2.59	3.19	1.97	0.35	2.21	2.97	1.17	0.86	1.79	1.90	1.07	0.75	1.12	2.37	1.63	1.81	0.93	2.32	0.83	0.19	0.21	2.12	0.94	1.5
Ins. available water remaining under each 3–6 ft. profile ..	3.32	3.74	2.90	1.66	2.49	3.23	1.61	2.74	2.31	2.86	2.01	2.32	2.02	2.91	2.99	3.79	2.19	3.13	3.11	1.11	0.19	2.73	1.99	2.35

Comparison of Moisture Storage and Utilization Effects under various Crop and Fallow Treatments at the end of the 1956 1959 Dry Seasons

	GN	*M*	*M*	*V.C.*	*To*	*To*	*M*	*GN*	*M*	*GN*	*M*	*TF*	*Bare Fallow*				*Teff*			*M*	*V.C.*	*V.C.*	*M*	*To*
Measurements	1956	1957	1958	1959	1956	1957	1958	1959	1956	1957	1958	1959	1956	1957	1958	1959	1956	1957	1958	1959	1956	1957	1958	1959
Ins. available water remaining under each 0–3 ft. profile ..	0.70	0.50	0.71	0.87	0.25	0.01	0.97	0.23	0.62	0.24	0.92	0.93	0.63	0.54	0.55	0.30	0.94	1.22	0.54	1.35	0.65	0.89	1.05	0.24
Ins. available water remaining under each 3–6 ft. profile ..	1.62	1.77	1.13	0.84	1.47	1.13	0.54	1.43	2.08	1.50	0.25	0.67	1.40	1.50	1.17	1.83	0.63	0.49	1.55	0.53	0.41	0.64	0.67	1.22

GN = groundnuts M = maize To = tobacco TF = teff V.C. = volunteer cover (indigenous grasses).
Rainfall. 1955/56 = 37.07 in. 1956/57 = 41.74 in. 1957/58 = 33.52 in. 1958/59 = 31.29 in.
Ins. available water between field capacity and wilting point for each 3 ft. of profile = 4.77 in.

TABLE IV

Moisture Characteristics of Soils from Chitedze and other Stations where investigational work is in progress

Location	*Description*	*Bulk (apparent) Density*	*Field Capacity (F.C.)*		*Wilting Point (W.P.)*		*Avail. Moisture (F.C.—W.P.)*	
			% Moisture held	*Water held ins./ft.*	*% Moisture held*	*Water held ins./ft.*	%	*ins./ft.*
Chitedze (A North)	Dark brown coarse loamy sand	1.66	14.10	2.81	6.53	1.30	7.57	1.51
Chitedze (C Zero) (water use expt.)	Dark reddish brown clay loam	1.36	23.48	3.80	13.67	2.21	9.81	1.59
Bvumbwe	Red sandy clay—clay	1.30	29.23	4.65	18.71	2.97	10.52	1.68
Swazi	Red clay	1.21	30.27	4.54	18.93	2.84	11.34	1.70
Makanga	Dark-grey brown clay loam	1.03	37.43	4.64	17.80	2.21	19.63	2.43

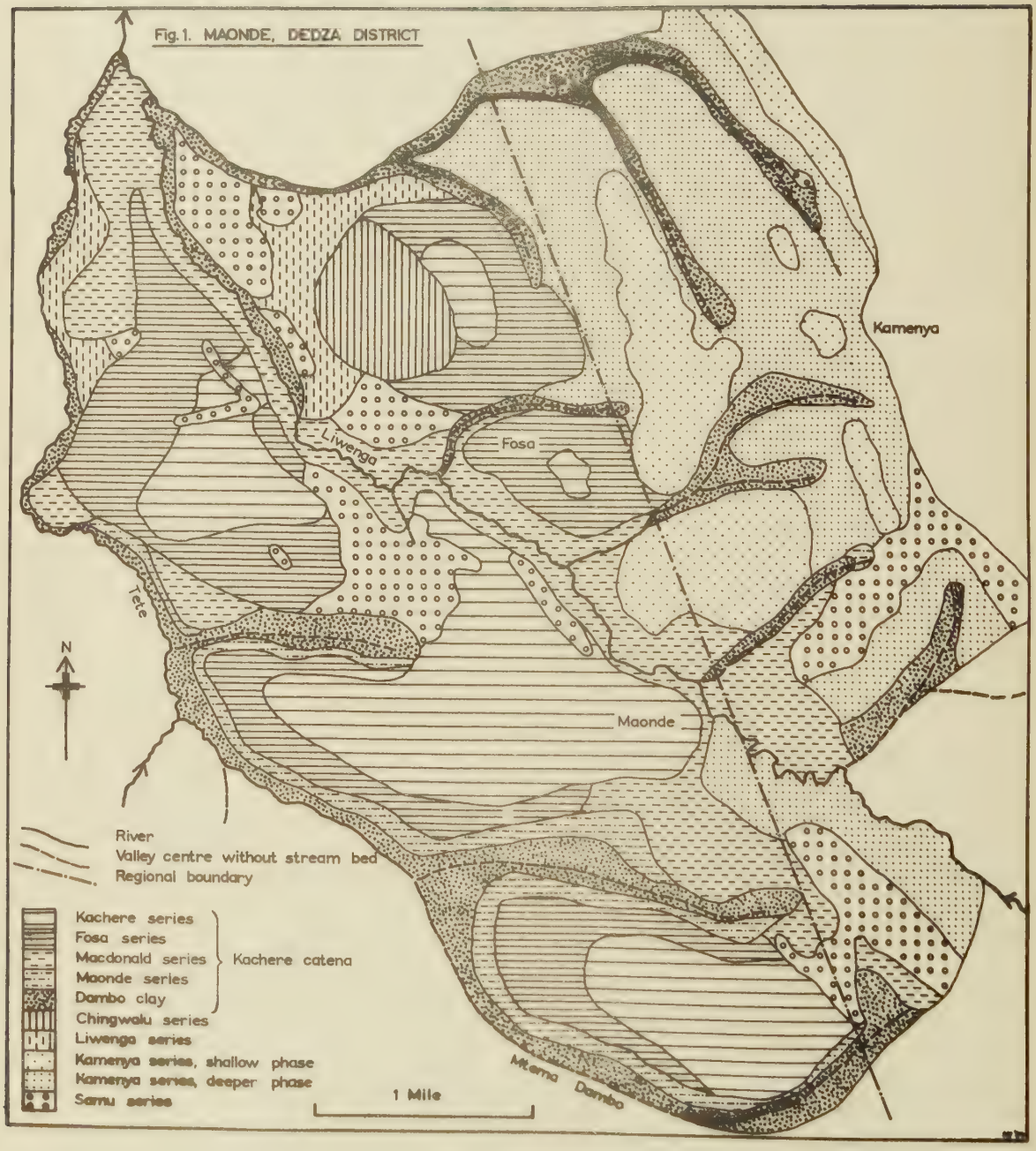
Fig. 1. MAONDE, DEDZA DISTRICT
Kamenya
Liwenga
Fosa
Tete
N
Maonde
River
Valley centre without stream bed
Regional boundary
Kachere series
Fosa series
Macdonald series
Maonde series
Dambo clay
Kachere catena
Chingwalu series
Liwenga series
Kamenya series, shallow phase
Kamenya series, deeper phase
Samu series
1 Mile
Mtema Dambo

SOIL SURVEYS

Two local soil surveys have been completed. The first, undertaken in conjunction with the Ecologist, was for advisory purposes for the Maonde Land Reorganization Scheme, Dedza District, which covers an area of 15 square miles. The second was of 115 square miles lying south-west of Nkata Bay. A survey of 250 square miles south and west of Chikwawa is in preparation. The following are condensed summaries of these surveys.

Maonde, Dedza District (*Figure* 1)

RELIEF AND DRAINAGE

The area lies 20 miles west of Dedza, at an altitude of 4,050–4,450 feet. It is underlain by Pre-Cambrian Basement Complex rocks of the Mozambique Series, striking NNW.–SSE. A lithological boundary following this strike direction, and passing a short distance east of Maonde, divides the area into two regions, differing not only in rock type but also in relief and soils.

In the south-western region the bedrocks are hornblende-biotite gneisses, the relief is independent of structure, and the soils generally deep. This region is occupied mainly by an erosion surface, with slopes of up to 1°, dissected into separate remnants by the Tete and Liwenga valleys and their tributaries. The tributary valleys are broad, shallow, and gently sloping, of the order of a quarter of a mile in width, with longitudinal slopes of $\frac{1}{2}°$ and valley sides of 2°; their central parts are continuously concave in cross-profile, without incised stream beds.

The north-eastern region is underlain by fine-grained gneissose syenites, the relief partly follows the strike direction, and the soils are shallower, weathered rock occurring within 3 feet of the surface. The relief consists of a series of ridges, with slopes mainly of 2°–4°, exceptionally 6°; the ridge crests are 50–200 feet higher than the erosion surface remnants of the south-western region. The tributary valleys are narrower and more steeply sloping, with longitudinal slopes of 1°–$1\frac{1}{2}°$ and valley sides of 2°–3°.

The Liwenga valley runs north-west across the centre of the area, cutting obliquely across the structure. It consists of two relief units: an outer valley, with sides of $2\frac{1}{2}°$–3°, and a narrow inner valley with slopes more than 5°. East of Maonde Village a broad terrace has been developed, lying 50 feet above the present river bed.

SOILS AND VEGETATION

1. The south-western region is occupied mainly by the *Kachere catena*. This is a well-developed catena of 5 series, bearing many similarities to the Ngongonda catena described in the Ecologist's report on the Mpingu Land Reorganization Scheme, Lilongwe District (*Ann. Rep. Dept. Agric.* 1957/8, pp. 140–144).

The uppermost member, occupying the almost level central parts of the erosion surface remnants, is the *Kachere series*. It is essentially a dark reddish brown sandy clay overlying dark red clay, deep, and freely drained in all horizons. It is moderately acid, pH 5.6, with lowish nitrogen and medium phosphate and potash. This and the following series are characterized by the presence of *Erythrina tomentosa* (Muale) and *Rauvolfia caffra* (Mwimbe); other species present are *Acacia campylacantha* (Ntete), *Combretum gueinzii*, *Albizzia gummifera* and *Dracaena* sp. The natural woodland is entirely cleared for cultivation; on old resting land there is an abundance of tall *Hyparrhenia* sp. A typical profile description is:

0–8 ins. 5YR 3/3 dark reddish brown sandy clay loam, very weak medium blocky structure, friable, moderate permeability, organic matter low, merging boundary.

8–27 ins. 5YR 4/4 dark reddish brown clay, with few gravel fragments, structure as above, slightly labile,* compact in lower part, moderate permeability, merging boundary.

27–48 ins. 2.5YR 3/5 dark red clay, some gravel, structure as above, labile, compact; a few roots penetrate to 48 ins.

2. Replacing this on the marginal parts of the surface remnants, sloping at $\frac{1}{2}°$–$1\frac{1}{2}°$, is the *Fosa series*. This is a dark brown sandy clay loam over a yellowish red sandy clay, becoming gravelly at 24 to 36 inches. The yellowish colour indicates less marked drying out than in the Kachere series, the iron oxides existing in a more hydrated form. The pH is slightly higher, and the nutrient status similar.

3. The *Macdonald series* consists of a dark brown sandy clay loam over a mottled clay, with pea-iron concretions present. It occupies valley sides and river terraces, and the subsoil drainage varies with site from imperfect to impeded. Reaction and nutrient status are as above. Vegetation species include those found on the Kachere series, but in addition *Pterocarpus rotundifolius* (Mbalitsa) is conspicuous, together with *Dombeya rotundifolia*. On the river terrace *Acacia campylacantha* and *A. woodii* are frequent.

0–8 ins. 10YR 2/2 very dark brown sandy clay loam, single grain structure, friable, moderate permeability, organic matter low, many fine root channels, merging boundary.

8–19 ins. Mottled 10YR 2/2 very dark brown and 10YR 4/4 dark yellowish brown, clay, with few pea-iron concretions, weak fine blocky structure, compact but friable, permeability slow, merging boundary.

19–33 ins. 7.5YR 4/4 brown, with many faint fine red and very dark greyish brown mottles, clay, pea-iron concretions common.

33–48 ins. 7.5YR 5/7 strong brown, with common faint fine redder mottle, clay, few pea-iron concretions.

4. The *Maonde series* is restricted to the concave slopes of valley sides and heads, on angles of 1°–$2\frac{1}{2}°$. A very dark grey sandy loam or loamy sand overlies a mottled sandy clay. The topsoil is formed by accumulations of colluvium, probably lens-shaped in section transverse to the valley side, washed from the slopes above. The moisture supply is augmented by subsoil seepage from these slopes, whilst owing to the location on concavities the drainage is impeded. The pH increases from 5.7 in the topsoil to 6.4 in the sandy clay. The vegetation of this seepage zone is characterized by tufted grassland, with *Hyparrhenia gazensis*, *Imperata cylindrica*, and tall *Setaria sphacelata*.

0–8 ins. 10YR 2/1 black sandy loam, single grain structure, friable, permeability rapid, organic matter low, abundant roots, with rhizomes in upper 2 ins., merging boundary.

8–15 ins. 10YR 4/1 dark grey, with coarser fragments stained brown, loamy coarse sand, with few pea-iron concretions, single grain structure, loose, permeability very rapid, clear wavy boundary.

15–24 ins. 10YR 5/1 grey, with common distinct fine yellowish brown mottle, coarse sandy clay loam, labile, compact, permeability slow, merging boundary.

* The term *labile* applied to soils means that when a moist lump is worked in the fingers it first breaks up, then the pieces re-form into plastic balls; soil consistency may be loose, friable, abile, plastic, or hard.

24–46 ins. 10YR 5/1 grey, with many prominent medium strong brown mottles, sandy clay, with abundant gravel-sized pea-iron concretions, below 30 ins. more than 50 per cent. pea-iron, structureless, plastic, permeability slow, sharp wavy boundary.

46–60 ins. 10YR 5/1 grey, mottle as above, clay, no concretions, massive, plastic; below 50 ins. whitish rotten rock grains appear and increase in frequency with depth; below 60 ins. almost entirely compact whitish coarse sand, greatly weathered rock.

5. The base of the catena, on valley floors, is occupied by *Dambo clay*, the topsoil black due to high organic matter under alkaline conditions, and the subsoil dark grey mottled yellowish brown. Drainage is very poor, and cattle trampling has frequently caused compaction of the topsoil. The clay is montmorillonitic, reaction weakly alkaline, and below 36 ins. a few calcium carbonate concretions are present. Between 6 and 24 ins. are patches of very fine non-cemented pea-iron, in places forming a thin, wavy, discontinuous horizon. This series is covered by *Hyparrhenia rufa* grassland; also present are *Paspalum comersonnii, Eulalia geniculata, Hemathria altissima*, and *Eragrostis atrovirens*, all grasses of the richer type of wet dambo.

6. At one point only the *Chingwalu series* replaces the Fosa series, but genetically it is probably not part of the Kachere catena. The texture is clay throughout, and the subsoil colour an extremely bright yellowish red (5YR 5/9). Drainage, acidity, and nutrient status are similar to the Fosa series, but manganese dioxide concretions occur between 9 and 28 ins.; these have a toxic effect on certain plants. The vegetation is quite distinct, consisting of woodland of *Brachystegia longifolia* and *B. floribunda*, with few other tree species, and a sparse ground cover.

7. In the *Liwenga series* a dark brown sandy clay loam overlies grey mottled clay, separated by a clear boundary. These soils originated as Dambo clays; rejuvenation of the main river left them in valley-side locations, and there has been a subsequent lightening of topsoil texture and improvement in drainage.

8. In the north-eastern region the *Kamenya catena* occurs; ridge crests, convexities, and valley sides are occupied by the Kamenya series, with Dambo clay in the valley floors. The *Kamenya series* is a shallow soil; a dark brown loamy sand to sandy loam, with single grain structure, rapid permeability, and low organic matter, overlies a gravelly horizon, passing into weathered rock at 12 to 24 ins. Shallow and deeper phases have been distinguished according to whether the rock lies above or below 18 ins. Both nutrient status and base exchange capacity are low. On the ridges the vegetation is characterized by *Brachystegia floribunda*, with *B. longifolia, Uapaca kirkiana*, and *Protea* sp.; the grass cover is sparse. On the lower slopes the vegetation resembles that of the Kachere series, with *Acacia campylacantha, Rauvolfia caffra*, and tall *Hyparrhenia* and *Setaria sphacelata*.

9. Within both regions there are substantial areas of *Samu series*, in which a horizon 12–24 ins. in thickness of partially cemented pea-iron occurs. It is found firstly on level and gently sloping land, and secondly as narrow outcrops on valley sides. The pea-iron horizon has a low permeability, giving the series imperfect drainage. The fertility level is low. Over much of the area a scrub woodland has resulted from over-cutting and grazing. It is dominated by scrub *Brachystegia longifolia* together with *B. stipulata, B. floribunda, Afrormosia angolensis, Ochna* sp. and *Uapaca kirkiana*, with a very sparse grass cover. Where there is no scrub a type of grass "common" is found. These commons are overgrazed and carry much *Sporobolus pyramidalis* with *Brachiaria humidicola* and *Eragrostis* sp.

0–15 ins. 10YR 3/1 very dark grey, with faint common fine dark yellowish brown mottle, sandy loam, single grain structure, friable, permeability rapid, organic matter low; pea-iron concretions few near surface, increasing with depth; clear smooth boundary,

15–38 ins. Almost entirely cemented pea-iron concretions, with grey sand; concretions mainly gravel-size, rounded, with purplish-black centres and thin rust-brown skins; in some cases two or more concentric skins are visible; cementation moderately hard, requiring pick to dig; permeability low, merging boundary.

38–48 ins. 10YR 5/1 grey sandy clay loam, with abundant whitish gravelly rock fragments; compact, but can be dug with spade.

THE FORMATION OF FERRICRETE

Of particular pedological interest is the occurrence in the Maonde area of ferricrete horizons of the pea-iron type at various stages of development. In the Dambo clay the high water-table mobilizes iron in the form of ferrous compounds, the supply being augmented from inflowing subsurface drainage water. During the long dry season there is a slight fall in the water table, giving aerobic conditions in the topsoil; under neutral to weakly acid conditions this results in the precipitation of part of the iron, giving fine, non-cemented concretions, often fairly soft.

When rejuvenation of the drainage system occurs the water-table is lowered, and under the prevailing climatic conditions seasonal alternations of aerobic and anaerobic conditions take place in the soil. As the water-table falls, iron becomes oxidized and precipitated in the ferric form; this is a non-reversible process, consequently the concretions grow in size. This stage is seen in the Maonde series (see profile description above).

Subsequent development may now take two directions. If the above conditions are maintained for a long period of time, the individual concretions grow until they coalesce; further precipitation cements them together and progressively fills in the interstices. Eventually further river incision lowers the water-table permanently beneath the soil, and the onset of permanently aerobic conditions terminates precipitation. Alternatively, these latter changes may take place before the cementation of individual concretions has proceeded far. In the first case the resultant horizon is rock-like, but with the original concretions still distinguishable, as in the Samu series profile described above. In the second the concretions can be broken apart readily; horizons of this nature also occur in the Samu series. The outcrops of ferricrete horizons on valley sides indicate former pauses in the lowering of the water-table by erosion.

LAND USE RECOMMENDATIONS

The Kachere and Fosa series are good arable soils, which will carry the full crop complex of the Maonde area with few hazards of cultivation. The Chingwalu series is liable to surface compaction and non-penetration of water; this appears to occur particularly under bush fallow. Consequently a rotation without fallow but including organic manuring is recommended. The Macdonald series produces good crops despite impeded subsoil drainage. The Maonde, Dambo clay, and Liwenga series provide dry season grazing lands. The shallower phase of the Kamenya series, of which *Uapaca kirkiana* is a good indicator, is unsuitable for cropping, and should be used for forestry and wet season grazing. The deeper phase constitutes the arable land of the Kamenya area; fertility is low on the upper slopes, but on the lower valley sides good crops appear to grow. The Samu soils are at present overgrazed and badly eroded, in some places down to the ferricrete horizon; they are classed as wet season grazing lands, but must be subject to careful management.

The amount of cultivable land per family is low, and there is a certain degree of fragmentation, including between husband's and wife's holdings. Conservation and re-allocation of gardens is desirable. Villages, particularly Maonde, cover an unnecessarily large area of the best soils, and an attempt should be make to deplete the size of these.

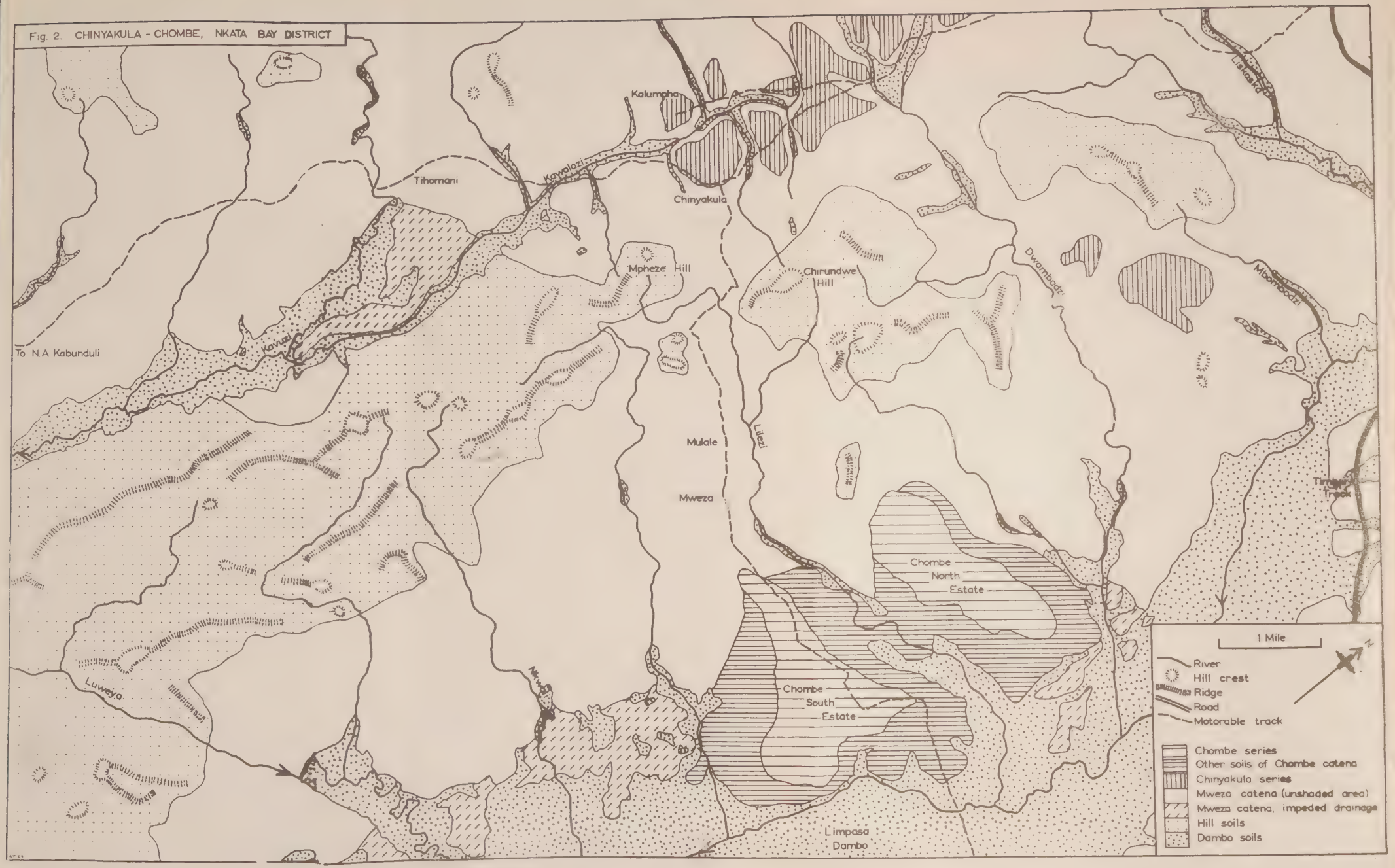
Fig. 2. CHINYAKULA - CHOMBE, NKATA BAY DISTRICT
Kalumpha
Tihomani
Kawalazi
Chinyakula
Mpheze Hill
Chirundwe Hill
Dwambadzi
Mbombadzi
Liskeaka
To N.A Kabunduli
To Kavuzi
Mulale
Mweza
Liezi
Chombe North Estate
Chombe South Estate
Luweya
Limpasa Dambo
1 Mile
N
River
Hill crest
Ridge
Road
Motorable track
Chombe series
Other soils of Chombe catena
Chinyakula series
Mweza catena (unshaded area)
Mweza catena, impeded drainage
Hill soils
Dambo soils

Priority should be given to grazing improvement and management; a system of cattle yarding should be introduced for the purpose of obtaining organic manures. Following scrub clearance, wet season grazings must be fenced and fertilized. The present badly eroded cattle tracks leading to dips must receive attention.

Chinyakula–Chombe, Nkata Bay District (*Figure* 2)

RELIEF AND DRAINAGE

For a distance of 15 miles south from Nkata Bay the broad, level, marshy belt of the Limpasa Dambo separates a coastal belt from higher ground inland. The survey covers part of the latter area, bounded approximately by the Timbili Track to the north, the Luweya river to the south, and extending inland slightly west of Chinyakula Village.

Rock specimens collected from the area have been identified by the Geological Survey as quartzitic mica-schists, the commonest type, hornblende gneisses, and biotitic granulites. They belong to the Mafingi Series, metamorphic Basement Complex rocks of Upper Pre-Cambrian age. They are strongly folded, striking approximately north-south and dipping steeply. This strike direction is followed by three major elements of relief, the Kavuzi–Kawalazi valley, the Limpasa Dambo, and the Chirundwe hill range; six minor streams within this range also follow a line of structural weakness.

A region approximately coincident with the Chombe Estates is underlain by a gritty coarse sandstone, of Cretaceous or Tertiary age. It forms a surface at 1,800–1,900 feet sloping very gently eastwards toward Lake Nyasa, probably a remnant of a former lake shoreline terrace. The free permeability of the rock has preserved this surface from dissection, except by the main Lilezi valley, giving relief forms and soil types quite distinct from the remainder of the area.

The drainage is ultimately toward the Limpasa Dambo and thence to Lake Nyasa. The dambo floor lies at 1,620 feet east of the Chombe Estates, and has probably risen by alluviation in the recent past; this has caused infilling of the lower courses of valleys draining into it, producing broad areas of dambo soils in their floors, and in some places isolating " islands " of higher ground.

A series of main rivers drain eastward into this dambo, including the Liskaska, Mbombodzi, Dwambadzi, Lilezi, and Nkwali. Five of these rivers rise in the Chirundwe hill range, whilst the Liskaska and Dwambadzi cut through it. The Lilezi also formerly flowed through this range, producing a col between Mpheze and Chirundwe hills; the Chombe–Chinyakula track runs through this gap, reaching a maximum height of 2,080 feet. The Lilezi headwaters have been captured by the extension, from the Luweya valley to the south, of the Kavuzi–Kawalazi river, following a line of structural weakness.

The detailed relief is affected by the impermeability of the Mafingi Series rocks, the relatively high rainfall, and the proximity of Lake Nyasa, the level of which has fallen intermittently during Tertiary and Quarternary times. This has resulted in intensive closely spaced dissection by steep-sided gullies over the majority of the area. Gully heads are steep, and extending rapidly; adjacent valley sides commonly meet in rounded crests, without any undissected area between. Only in two limited areas, shown by the Chinyakula series on figure 2, is a level surface at 2,000 feet preserved.

The Limpasa and Luweya rivers are perennial. The smaller streams cease to flow in the dry season, although many retain pools.

SOILS

1. The soils overlying coarse sandstones on the Chombe Estates are named the *Chombe catena*, and the uppermost member of this catena, occupying the level surface,

the *Chombe series*. This consists of a dark brown sandy loam passing gradually into a red sandy clay loam at 12 to 24 ins. The most distinctive feature is the high proportion of coarse sand, varying from 45–60 per cent. in the topsoil and decreasing only slightly with depth. The high rainfall, rapid permeability, and non-basic parent material result in an unusually high acidity, pH 4.2; these factors also produce clay of a kaolinitic type, with low base exchange capacity. Nitrogen status is lowish, and potash low.

0–8 ins. 7.5YR 3/2 dark brown, in places 5YR 3/4 dark reddish brown, coarse sandy loam, friable, almost loose, permeability rapid, merging boundary.

8–30 ins. Colour as above but with very faint fine dark red mottle, sandy clay loam, single grain structure.

30–48 ins. 2.5 YR 4/8 red sandy clay loam, more clay than above, stoneless, labile, permeability moderate.

2. The slopes bounding this surface are occupied by the lower members of the Chombe catena; these have been described by the Ecologist (*Ann. Rep. Dept. Agric.* 1955/6, Part II, pp. 85–89). Marginal to the Chombe series is a narrow belt with the topsoil less sandy and redder. Bordering the valley floors the colour becomes yellowish red and the subsoil distinctly mottled, due to drainage impedance.

3. The limited areas of undissected surface on the Mafingi Series rocks are occupied by the *Chinyakula series;* these surface remnants slope at $\frac{1}{2}°$–1° towards relatively narrow, steep-sided bounding valleys. A dark reddish brown sandy clay loam overlies a red sandy clay, the red colour becoming strikingly bright in the deeper parts. It is freely drained throughout, but water retention is satisfactory. In the lower horizons fine gravel amounts to 1 per cent. of the total soil. This series is slightly less acid than the Chombe, pH 4.5–4.8, owing to its derivation by primary weathering from igneous rocks. Nutrient status, although still low, is greater than that of the Chombe series.

0–12 ins. 2.5YR 3/4 dark reddish brown sandy clay loam, stoneless, friable, permeability moderate.

12–20 ins. 10R 3/4 dusky red, sandy clay loam to sandy clay; a transitional horizon, with both upper and lower boundaries merging.

20–48 ins. 10R 4/6 red sandy clay, a few fine fragments of quartzite gravel, otherwise stoneless; friable, slightly labile, permeability moderate.

4. The soils of the dissected country occupying the greater part of the area are named the *Mweza catena*. The relief consists typically of rectilinear valley sides, sloping between 20° and 28°, separated by continuously convex ridges. On the ridges and upper parts of the valley sides is a shallow yellowish red sandy clay loam, with many quartzite stones, passing into rock at between 6 and 20 ins. Downslope the depth increases, giving on the lower part of the catena:

0–6 ins. 5YR 4/6 yellowish red sandy clay loam, almost stoneless, micaceous, labile, permeability moderate.

6–24 ins. 2.5YR 3/6 dark red sandy clay loam, some quartzite gravel, few stones, friable.

24–42 ins. 2.5YR 3/6 dark red sandy clay loam, gravelly, stones common, proportion of weathered rock increasing with depth but still augerable at 42 ins.

An area near the Luweya with less dissection and a soil depth of 36 ins. is included with the Mweza catena. Certain other areas, which have not been investigated, are mapped from their location and appearance on air photographs as having impeded subsoil drainage.

5. On the *hill areas* the soils are similar to the Mweza catena, but thinner and stonier, with rock outcrops on the upper slopes.

6. The *dambo soils* are divisible into two groups. In the smaller patches within the area of the Mweza catena a dark brown topsoil overlies a yellowish red sandy clay subsoil, with drainage impedance below 24 ins. The broad dambos are waterlogged to the surface for the greater part of the year, with a grey clay soil.

CLIMATE AND VEGETATION

The rainfall data have been summarized by the Ecologist (loc. cit.), and more detailed recent records confirm this account. The majority of the area receives about 90 ins. a year, of which 15 per cent. falls in the six winter months. A rain-shadow effect might be expected from the Chirundwe hill range, but this is not apparent in the vegetation, nor in such records as are available. Mean annual evaporation is about 80 ins. at the Lake-shore, decreasing with altitude.

There is a simple division between forest, woodland, and grassland, which corresponds to the soil types. On the Chombe and Chinyakula series there is forest, with an 80 ft. high canopy of *Brachystegia spiciformis*, beneath which is a dense evergreen understory. This understory consists mainly of shrubs, with creepers present; it is not possible to see far through it, nor to walk through. The grass layer is completely suppressed. Trees present include *Anisophyllea pomifera* and *Erythrophloeum maraviense;* an easily recognizable indicator is the creeper *Smilax kraussiana*, with its thorny stem and hooked petiole.

In clear contrast to this, the Mweza catena and the hill soils are covered by woodland. The canopy is between 60 and 80 ft. in height, and generally contains *Pseudoberlinea globiflora, Brachystegia longifolia*, or *B. boehmii* in addition to the dominant *B. spiciformis*. The shrub layer is moderately open to sparse, and can be seen through for some distance and walked through. A sparse to very sparse grass layer is present. *Anisophyllea pomifera* is present as an understory tree in this vegetation also, together with *Uapaca kirkiana, Parinari mobola*, and *Tricalysia nyassae.*

LAND USE

Estate agriculture, formerly for rubber and since 1956 for tea, is practised on Chombe South Estate. The remainder of the area is sparsely populated by Atonga. At present only a small proportion of the natural vegetation has been cleared for cultivation, but further clearance is proceeding rapidly. Much of this cleared area is on steep slopes. The practice is to take a crop of maize or sorghum in the year following clearance, and thereafter to carry out a monoculture of cassava, grown on mounds; there are no contour ridges. Combined with the high rainfall, this leads to rapid erosion. Several areas are visible on the air photographs on which it appears that the vegetation has been cleared and at a later date cultivation abandoned. It is probable that the previous vegetation will not regenerate for a considerable period of time.

Adequate soil conservation works would be difficult to construct and maintain, owing to the highly broken topography, consequently some restriction of the further extension of cultivation is desirable. Several tree species providing valuable timber are present in the natural vegetation, including *Pterocarpus angolensis, Burkea africana*, and *Erythrophloeum maraviense.* It is recommended that an investigation of timber resources should be carried out, with a view to the creation of a forest reserve. This would form a north-south belt, including all the areas mapped as hill soils, together with parts of the Mweza catena lying between and to the east of the hill areas. The present population in such a belt is small.

The Agro-Ecological Survey of Nyasaland

A survey has been commenced with the objects of assessing the total agricultural resources of the country, and mapping the distribution of these resources. This will provide a basis for cropping programmes, re-settlement projects, and other aspects of overall agricultural planning. It will put on permanent record the local knowledge of District staff, and provide a co-ordinating framework for research and experimental work.

Previous work on soils in Nyasaland has consisted mainly of detailed local surveys, and chemical analyses undertaken for advisory purposes. As a result, a considerable number of soil series have been identified, but comparatively little is known about their areal extent and distribution. Consequently the survey will include preparation of a reconnaissance soil map of the whole country. This will be undertaken by the Soil Surveyor, Ecologist, Agricultural Chemists, and District staff in co-operation. Where possible air photograph interpretation will be employed in the delineation of boundaries. A map of the Northern Province will be available in manuscript form by July, 1960.

Other maps and accounts of landforms, climate, vegetation, population, and present agricultural practices will be prepared, partly from existing data and partly by original survey. These factors will be synthesized in a map of agro-ecological regions; these are regions in which the environmental factors affecting agricultural potentialities are uniform. It is intended to make the results accessible in published form.

REPORT OF THE PLANT PATHOLOGIST

The Plant Pathologist was on leave from 1st March, 1959, to 7th September, 1959.

A number of new collections have been made:

Camellia sinensis (L) Kuntze—Tea.

Hypocrella javanica (Penz and Sacc) Petch. parasitic on scale insects present on twigs.

Cenchrus ciliaris L.—African foxtail.

Cerebella andropogonis Ces.—False smut.

Coffea arabica L.—Coffee.

Ascochyta tarda Stewart. Dieback and leafspot.

Crotalaria juncea L.—Sunn hemp.

Fusarium equiseti (Corda) Sacc. Wilt.

Dolichos lablab L.

Elsinoe dolichi Jenkins, Bitancourt & Choe. Stem canker.

Eucalyptus saligna Sm.

Cytospora sp. (possibly conidial *Valsa eucalypti* Cooke & Harkness)—Canker.

Glycine javanica L.

Synchytrium dolichi (Cooke) Gaumann—False rust.

Gmelina arborea L.

Cercospora volkameriae Speg.—Leafspot.

Morus nigra L.—Mulberry.

Phleospora mori (Lev) Sacc.—Leafspot.

Nicotiana tabacum L.—Burley Tobacco.

Fusarium oxysporum f. nicotianae (Johns) Snyder & Hansen. Fusarium wilt.

Passiflora edulis Sims.—~~Granadilla.~~ Passion fruit

Passion fruit woodiness disease due to Cucumber mosaic virus.

Pennisetum purpureum Schum.—Elephant Grass.

Beniowskia sphaeroidea (K & C) Mason—False mildew.

Pinus sp.

Armillaria mellea (Fr.) Quel—Collar rot.

Solanum panduraeforme E. May.

Helminthosporium halodes Drechsler—Leafspot.

Solanum tuberosum L.—Potato.

Phytophthora infestans (Mont) de Bary. Late Blight.

Urochloa pullulans Stapf.

Ustilago urochloana Zundel—Smut.

Vigna unguiculata (L) Walp.—Cowpea.

Ascochyta phaseolorum Sacc. Zonate leafspot.

Voandzeia subterranea Thouars.—Bambara groundnut.

Cercospora canescens Ell. & Mart. Leafspot.

This list includes several items of interest. *Ascochyta tarda* on coffee has, as far as I am aware, only been recorded previously from Ethiopia and possibly Eritrea (Stewart (1957) in Mycologia, 49, 430). The canker on *Eucalyptus saligna* which is associated with the *Cytospora* sp. appears to be the main reason for the failure of *Eucalyptus* in the Lilongwe area. This disease is consequently of major importance. Fusarium wilt on burley tobacco appears to be increasing, and may become a major factor in burley production in the main producing areas in the Central Province. Pathogenicity tests have finally shown the fungus to be definitely *Fusarium oxysporum f. nicotianae* Johns (Snyder & Hansen) after provisional diagnosis as this fungus by Dr. W. L. Gordon of Canada. The advent of Late Blight on potatoes occurred in the year under review. It was known that this disease would finally make its appearance but it has come in rather earlier than anticipated. Preliminary indications are that it will cause very widespread destruction in the main potato growing areas, where climatic conditions are near optimum for its spread and development.

The Pathologist is greatly indebted to the Director and Staff of the C.M.I. for continued help in identification of pathogens.

REPORT OF THE ENTOMOLOGIST

Introduction

Investigations into the control and biology of the Maize Stalk Borer (*Busseola fusca* Hmps and *Chilo zonellus* Swinh) have again been the Entomologist's major field of work. The technique of dusting young maize plants 18 inches high and using a tin with four holes punched in the base with a 1 inch nail has now been successfully carried out by African cultivators themselves on demonstration strips in their gardens. In the Dedza Highlands and Northern Province these demonstrations gave striking results and the people were favourably impressed by them. The staff of the Entomological Laboratory once again gave assistance to the Cotton Pest Research Scheme by conducting experiments at Toleza Farm, Balaka. The results of these experiments will be found in the Report of the Cotton Pest Research Team.

Experimental Work on Maize Stalk Borer control

At Bvumbwe an observational trial was carried out to compare formulations of Endrin 1 per cent. granules with 5 per cent. and 10 per cent. D.D.T. dust. The actual borer attack was very low but Endrin gave an almost complete kill of all larvae present. The Endrin also caused a marked scrock on the leaves but later the plants grew away from this.

At Bembeke, in the Dedza Highlands, and at Dzeleka in the Dowa Hills replicated experiments using D.D.T. were carried out but the borer attack was so slight that no significant effect of the insecticide was apparent.

At Nchenachena, in the Northern Province, the maize was planted at the end of October before the rains began by using irrigation. The maize was heavily attacked by borer though the timing was somewhat later in the plant's development than in maize planted after the arrival of the rains. The results of this experiment are given in Table I.

Object To test D.D.T. as control for Maize Stalk Borer.

Design Randomized blocks, 4 replications.

Treatments a. No insecticide.
b. 10 lb. p.a. 10 per cent. D.D.T. dust (1 application)
c. 10 lb. p.a. 10 per cent. D.D.T. dust (2 applications)

O. No fertilizer.

N. 200 lb. p.a. sulphate of ammonia.

TABLE I

Yield of maize in lb. grain per acre (at 72 per cent. shelling)

Treatment	*a*	*b*	*c*	*Mean*	
O	784	1,474	1,758	1,339	Not
N	1,248	1,316	1,900	1,488	significant
Mean	1,016	1,395	1,828	1,413	

L.S.D. (P=0.01) 422 lb. per acre
No significant interaction.

These results show a high increase in yield for the application of D.D.T. especially when the treatment is split into two applications. Previous experiments have not shown any advantage to split applications and the explanation may lie in the fact that the very early planted maize made the plants attractive to the whole moth emergence. Laboratory experiments have shown that the period of emergence may extend to six weeks.

A count of plants that had been attacked was made in April and are given in Table II. These figures give a picture of the magnitude of the attack and are in agreement with the yield figures.

TABLE II

Numbers of stem bored plants (April)

Treatment	*a*	*b*	*c*	*Mean per plot*	
O	267	180	99	30	Not significant
N	205	184	100	37	
Mean per plot ..	79	60	33		

L.S.D.=16 P=0.001
Interaction not significant.

In this experiment there was no yield response to application of nitrogenous fertilizer and no increase in borer attack. In the Bembeke experiment there was a marked yield increase due to fertilizer and though the insect population was small there was an increase in the number of stem bored plants (Table III). It is possible that where there is an increase in yield due to fertilizer there may also be an increase in the severity of borer attack.

TABLE III

Stem bored counts (Bembeke)

*Treatment**	*Nil*	1	*Total*
O	11	4	15
N	24	19	43
Total	35	23	58

*Symbols O=No nitrogen.
N=100 lb./acre S.A.
Nil=no D.D.T.
1=10% D.D.T. at 10 lb./acre

Laboratory Experiments

During the 1957/58 season Maize Stalk Borer incidence appeared to be low, even in the Highland areas where it is usually a troublesome pest. This was thought to be due to the extended dry season, the conclusion of which was characterized by abnormally high temperatures which would adversely affect the survival of diapause larvae. In an effort to find the reaction of diapause larvae to high temperature and low humidities experiments were set up in the laboratory where larvae in piece of maize stalk were kept at mean daily temperatures of 80° F., a constant temperature of 85° F., and at humidities in the range 25 per cent. R.H., 35 per cent. R.H., 75 per cent. R.H., and 90 per cent. R.H. The experiments were set up at the beginning of June and mortality of larvae was recorded from the end of August. The actual rate of mortality did not appear to differ in any of the treatments, and continued steadily until January. The percentage of larvae dying, however, was greatest in the treatments having 85° F. constant and an R.H. of 25 per cent. Survival was best at a

mean temperature of 80° F. and an R.H. of 35 per cent.–40 per cent. or at a constant 85° F. and R.H. 75 per cent. At R.H. above this, however, survival rate appeared to be poorer. Since even the high R.H. per cent. did not appear to lead to pupation and emergence of moths, some of the pieces of maize stalk from each treatment were soaked in water to simulate the effect of a heavy shower of rain. This procedure caused pupation and subsequent emergence of adults.

Conclusion to Maize Stalk Borer Experiments

It is evident therefore that a prolonged dry season ending with high temperature and low humidities will adversely affect larval survival; it is also evident that the first heavy showers of rain will " trigger off " pupation, and emergence will follow in about 14 days. It follows, therefore, that in the Highland areas of Nyasaland a high incidence of borer can be expected in those crop years preceded by a not unduly long dry season whose effects are mitigated by light showers. Attacks may be expected to be worst when maize is planted after the first soaking rainstorms and when these are followed by steady rains within 2–3 weeks. There is some evidence to suggest that nitrogen application will cause heavier attack.

Experiments over the past two seasons have shown that such attacks can easily and economically be controlled by an application of 10 lb./acre of 10 per cent. D.D.T. dust, shaken into the funnel of the maize plant when it is 18 inches high. When the rains are early and the emergence period may be expected to be prolonged there would appear to be some advantage in splitting the application into two dressings 14 days apart.

The following species are recorded as new to Nyasaland; grateful acknowledgement is made to the Commonwealth Institute of Entomology for making the identifications.

HEMIPTERA

COCCIDAE

Aonidiella aurantii Mask.
Orthezia insignis Browne

COLEOPTERA

CARABIDAE

Chlaeniostenodes coerulipennis Boh.

NITIDULIDAE

Haptoncus dispersus Grouv.

MALACHIIDAE

Apalochrus appendicifer Pic.

ELATERIDAE

Tetralobus subsulcatus Guer.

MELOLONTHIDAE

Trochalus sp. nr. *aeruginosus* Burm.

DYNASTIDAE

Heteronychus sp. ? *licas* Klug
Heteronychus sp. nr. *dissidens* Per.

CETONIIDAE

Trymodera aterrima Gerst.

TENEBRIONIDAE

Strongylium suspicax Klbe.
Curimosphena fasciculosus Per.

CURCULIONIDAE

Phymatopsinus pustula Ancey

Pseudomimus sp.

BRUCHIDAE

Caryopemon cruciger Steph.

CLYTRIDAE

Diapromorpha argentata F. var.

HALTICIDAE

Podagrica weisei Jac.

GALERUCIDAE

Laetiacantha distincta Gah.

CASSIDIDAE

Aspidomorpha quadrimaculata Ol.

HYMENOPTERA

APIDAE (MELIPONIDAE)

Hypotrigona bottegoi Magr.

SPHEGIDAE

Bembex massaica Cameron

ICHNEUMONIDAE

Pristomerus sp.

PTEROMALIDAE

Pachyneuron sp.

LEPIDOPTERA

GEOMETRIDAE (D. S. Fletcher det.)

Prasinocyma angolica Prout.

PYRALIDAE (W. H. T. Tams det.)

Sceliodes laisalis Walk.

Crocidolomia suffusalis Hmps.

SATURNIIDAE (W. H. T. Tams det.)

Nudaurelia rendalli Rths.

HEMIPTERA

COREIDAE

Homoeocerus sp.

BERYTIDAE

Metacanthus sp.

APHIDIDAE (V. F. Eastop det.)

Toxoptera aurantii (B.d.F.)

ORTHOPTERA

ACRIDIDAE

Chrotogonus hemipterus Schaum.

LIST OF PUBLICATIONS FOR THE PAST THREE YEARS

1. Pereira, H. C., Wood, R. A., Brzostowski, H. W. and Hosegood, R. H. " Water conservation by fallowing in semi-arid tropical East Africa." *Empire Journal of Experimental Agriculture*, Vol. 26.

2. Foster, L. J. and Wood, R. A. " Further aspects of strawberry culture in Nyasaland." *Rhodesian Agricultural Journal*, Vol. 56.

3. Cutting, C. V., Wood, R. A., Brown, P. and Ambrose, H. B. " Assessment of fertility status and the maintenance of productivity of soils in Nyasaland." Paper presented at the 3rd Inter-African Soils Conference (in Press).

4. Laycock, D. H. and Wood, R. A. " The importance of soil moisture in Nyasaland tea soils." Paper presented at the 3rd Inter-African Soils Conference (in Press).

5. Wood, R. A. " Determining water use of vegetation in Nyasaland by changes in Soil Moisture storage." *Nyasaland Farmer and Forester* (in Press).

6. Brown, P. " Results of some short term rotation experiments in Nyasaland." *Rhodesian Agricultural Journal*, Vol. 55, No. 4.

7. Brown, P. " Maize cultivation trials 1947–1957." *Nyasaland Farmer and Forester*, Vol. 4, No. 2.

8. Brown, P. " Modern trends with pastures and their management." *Nyasaland Farmer and Forester*, Vol. 4, No. 1.

9. Ellis, R. T. " Note on the Layout of Maize Field Trials." *Empire Journal of Experimental Agriculture*, Vol. 27, No. 107.

10. Ellis, R. T. " The food properties of flint and dent Maize." *East African Agricultural Journal*, Vol. 24, No. 4.

11. Ellis, R. T. " Maize Breeding in Nyasaland." *Rhodesian Farmer*, Vol. 30, No. 13.

12. Foster, L. J. and Craske, G. F. " Coffee Harvesting and Processing." *Nyasaland Farmer and Forester*, Vol. 3, No. 2.

13. Foster, L. J. " Gardening Notes," I, II and III. *Nyasaland Farmer and Forester*, Vol. 4, Nos. 2, 3, 4.

14. Foster, L. J., " Fruit Growing Prospects in Nyasaland." Published by the the Government Printer, Zomba.

15. Foster, L. J. " Trial of Strawberry Varieties in Nyasaland." *Rhodesian Agricultural Journal*, Vol. 55, No. 5.

16. Foster, L. J. " Coffee-Growing Prospects in Nyasaland." Reprinted from the *Nyasaland Farmer and Forester*, Vol. 4, No. 4.

17. Cutting, C. V. " Soil Analysis—its Significance in Agriculture." *Nyasaland Farmer and Forester*, Vol. 3, No. 2.

18. Cutting, C. V. " Nyasaland Tea Soils—their Nutrient Status." *Nyasaland Farmer and Forester*, Vol. 3, No. 2.

19. Cutting, C. V. " Soils of the Elephant Marsh." *Nyasaland Farmer and Forester*, Vol. 3, No. 4.

20. Cutting, C. V. and Foster, L. J. " Some Nutritional Aspects of Pasture Management in the Cholo area." *Nyasaland Farmer and Forester*, Vol. 4, No. 2.

21. Cutting, C. V. (in conjunction with Tea Research Station staff). " Fertilizers for Nyasaland Tea."

22. Cutting, C. V. " African Agriculture in Nyasaland." (Chapter I—" Soil ".)

23. Laycock, D. H. " Experiments on the use of transplanted stumps for establishing tea in Nyasaland." *Tropical Agriculture*, Vol. 34, No. 3.

24. Laycock, D. H. " An empirical relationship between rainfall and tea yields." A paper read to the E.A.A.T.R.O. conference in February, 1958. (Published by the Government Printer, Zomba.)

25. Laycock, D. H. " Progress Report on the First Six Years of a Pruning Experiment with Nyasaland Tea." *Tropical Agriculture* (in the Press).